THE TAXONOMY AND BIOSTRATIGRAPHY OF THE ORDOVICIAN AND EARLY SILURIAN ARTICULATE BRACHIOPODS OF TASMANIA

by

obertson

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Except as stated herein, this thesis contains no material which has been accepted for the award of any other degree or diploma in any university and, to the best of my knowledge and belief, this thesis contains no copy or paraphrase of material previously published or written by another person, except when reference is made in the text of the thesis.

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ABSTRACT

The Ordovician to earliest Silurian rocks of Tasmania belong to, or are correlates of, one of two subgroups ; the Denison Subgroup, a 3400 metre clastic sequence ranging in age from Franconian to Late Canadian, or the Gordon Subgroup, a 1200 - 1800 metre carbonate sequence ranging in age from Late Canadian or Whiterock to Early Llandovery. The rocks comprising the formations of these subgroups are, in the main, richly fossiliferous with articulate brachiopods and trilobites being the most ubiquitous elements of the fauna. Inarticulate brachiopods are very rare.

Of the 60 species of brachiopod described herein, 42 are new. These 60 species belong to 42 genera of which 7 are new. Two new families and two new subfamilies are erected.

A biostratigraphic scheme for the sequence of brachiopod faunas has been erected. This consists of 20 zones and an uppermost informal assemblage. The zones in ascending order are:- *Apheoorthis humboldtensis* zone which is characterised by the nominal species; *Nanorthis, carinata* zone which contains the nominal species and *Apheoorthis humboldtensis* Laurie 1980 ; *Tritoechia lewisi* zone which contains *T. lewisi* Brown 1948 and *Syntrophopsis*

karmbergi Brown 1948 ; *Tritoechia florentinensis* zone which contains *T. florentinensis* Laurie 1980 only ; *?Tritoechia careyi* zone which contains *?T. careyi* Brown 1948 only ; *Leptella corbetti* zone which contains *L. corbetti* sp. nov., *Tritoechia karmbergensis* Laurie 1980 and *Archaeorthis subcarinata* Laurie 1980 ; *Hesperonomiella jurikae* zone which contains *H. jurikae* sp. nov. only ; *Railtonella scanloni* zone which contains *R. scanloni* gen.et sp. nov. and *Hesperonomiella jurikae* sp. nov. ; *Aporthophyla staiti* zone which contains *A. staiti* sp. nov., an indeterminate orthide and an indeterminate porambonitacean; *Leptellina sulcata* zone which contains *L. sulcata* sp. nov. and an indeterminate strophomenacean; *Lepidomena fortimuscula* zone which contains *L. fortimuscula* gen.et sp. nov., *Rhynchotrema bailliei* sp. nov., *Apatomorpha melrosensis* sp. nov., *?Strophomena* sp., *Bellimurina* cf. *compressa* Cooper 1956, *Hesperorthis longirostroides* sp. nov., *Dactylogonia rara* sp. nov., *Chaganella* sp., *Teratelasmella plicata* gen.et sp. nov., ? *Ptychopleurella* sp., oepikinid gen.et sp. indet. and an indeterminate orthide; *Lepidomena pulchra* zone which contains *L. pulchra* gen.et sp. nov., *Oepikina banksi* sp. nov., *Hesperorthis longirostroides* sp. nov., ? *Rhynchotrema* sp., *Rhynchotrema bailliei* sp. nov. *Azamella* sp. and *Chaganella* sp. ; *Tasmanorthis calveri* zone which contains *T. calveri* gen. et sp. nov., *Azamella rotunda* gen.et sp. nov. and *Rhynchotrema ponderosa* sp. nov. ; *Tasmanorthis costata* zone which contains *T. costata* gen.et sp. nov., Azamella sulcata gen. et. sp. nov., Macrocoelia stenomuscula sp. nov., Skenidioides alatus sp. nov., Ptychopleurella magna sp. nov., Rhynchotrema crossi sp. nov. and Murinella magna sp. nov.; Strophomena cf. oklahomensis zone which contains S. cf. oklahomensis Cooper 1956, Tasmanorthis costata gen.et sp. nov., Ptychopleurella cf. magna sp. nov., Azamella sulcata gen.et sp. nov. and an indeterminate atrypide ; Dinorthis westfieldensis zone which contains D. westfieldensis sp. nov, Strophomena burretti sp. nov., Rhynchotrema ?iowense Wang 1949, Protozyga aseptata sp. nov., Hallina inconspicua sp. nov., Macrocoelia brownae sp. nov., Tasmanella nova gen.et sp. nov., Ptychopleurella cf. magna sp. nov., Hesperorthis benjaminensis sp. nov., Sowerbyites vesciseptus Percival 1979, Holtedahlina sp., Sowerbyella (Sowerbyella) cf. anticipata Percival 1979 and Sowerbyella (Sowerbyella) ? lepta Percival 1979; ?Plectorthis dinorthoides zone which contains ?P. dinorthoides sp. nov. and Tasmanella nova gen.et sp. nov, ; Dinorthis holdenoides zone which contains D. holdenoides sp. nov., Rhynchotrema sp., Ptychopleurella sp., Hesperorthis sp. and two indeterminate atrypides ; Isorthis (Ovalella) arndellensis zone which contains I. (O) arndellensis sp. nov., Hirnantia enorme sp. nov. ; ?Onniella perplexa zone which contains ?O. perplexa so. nov., Isorthis (Ovalella) arndellensis sp. nov.,

?Eospirifer sp., *Hirnantia* sp. and an indeterminate leptaenid. At the top of the Gordon Subgroup in the Florentine Valley is a single horizon, designated herein the *Kinnella ?kielanae* assemblage which contains *K. ?kielanae* (Temple) and an indeterminate leptaenid.

A brachiopod fauna associated with a small stromatoporoid mound in the Cashions Creek Limestone of the Florentine Valley was examined and found to be much more diverse than, and generically distinct from, that found in the surrounding sediments.

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CHAPTER I

INTRODUCTION

AIMS

The major aims of this study are to describe the brachiopods contained in, and to erect a brachiopod biostratigraphy for, the upper Denison Subgroup and the entire Gordon Subgroup based largely upon sections in and adjacent to the Florentine Valley of southwestern Tasmania. Correlation of these sequences with sequences elsewhere in Tasmania, other parts of Australia and in other continents will also be attempted.

GENERAL STRATIGRAPHY

The Denison Subgroup (Corbett,1975), in its type area (Denison Range, southwestern Tasmania) is a 3 400 metre thick clastic sequence ranging in age from Franconian (Late Cambrian) to Late Canadian (Early Ordovician). The overlying Gordon Subgroup (Corbett & Banks 1974, 1975), in its type area (southern Florentine Valley), is a 1 200-1 800 metre thick (Corbett & Banks 1974,p. 220), predominantly carbonate sequence ranging in age from Late Canadian or Whiterock (Early Ordovician) to Early Llandovery (Early Silurian).

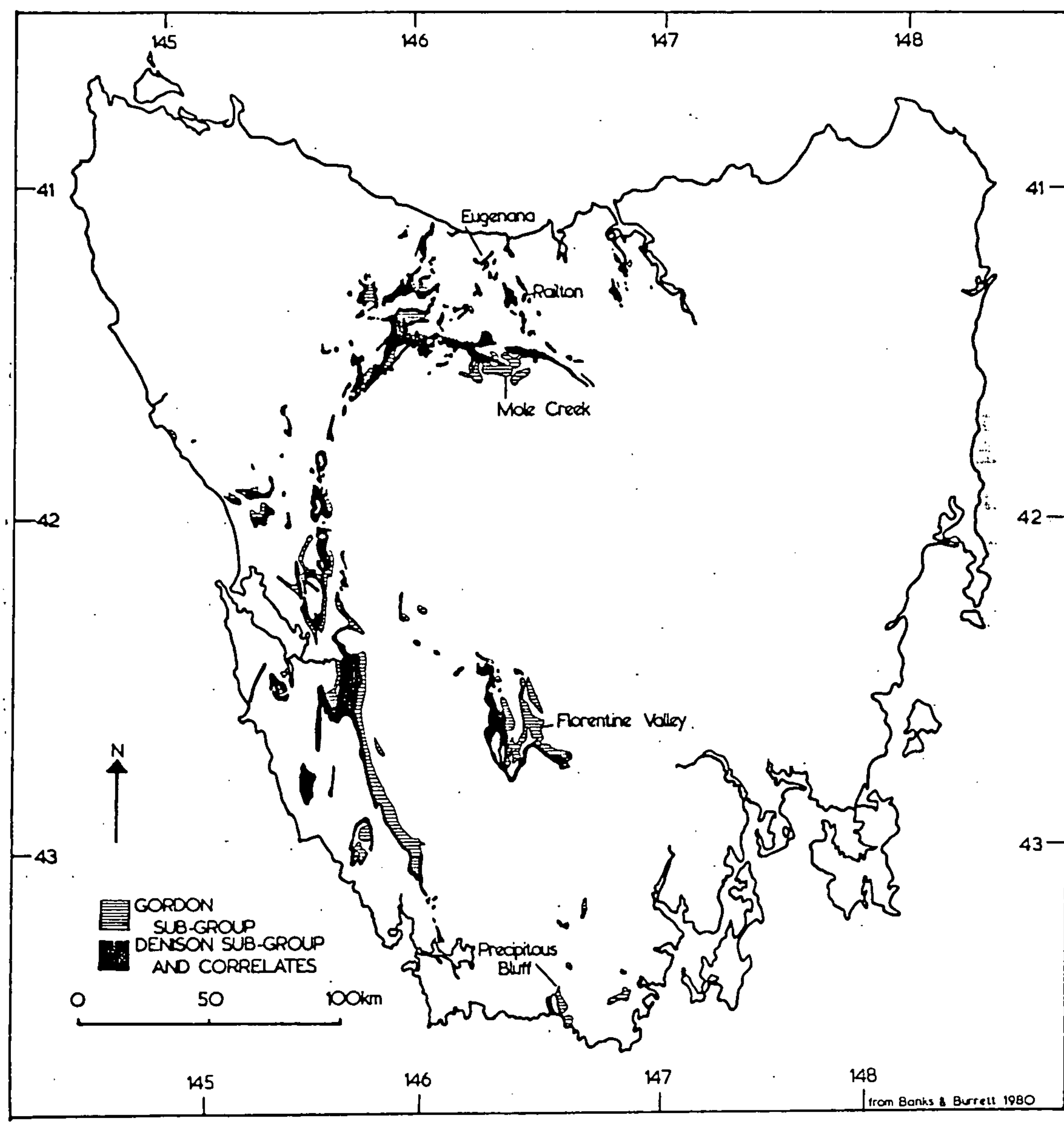
Both of these subgroups, or correlates thereof are extensively developed in the western half of Tasmania (see fig.1.1). The constituent formations of the Denison Subgroup and their lithological correlates near the Florentine Valley are shown in fig. 1.2. The uppermost formation of this subgroup, the Squirrel Creek Formation correlates (both lithologically and biostratigraphically) with the Florentine Valley Formation further east (Stait & Laurie 1980,p.202-3). This latter formation outcrops to the southeast of the Florentine Valley and is the only portion of the Denison Subgroup from southern Tasmania to be dealt with in this study.

As the base of the Gordon Subgroup is considerably younger in the north of the state than it is in the Florentine Valley, the clastics underlying the carbonates in the north of the state are dealt with in greater detail than those in the south.

The Gordon Subgroup is, in general, highly fossiliferous and the brachiopod faunas of all the constituent formations: the Karmberg Limestone, Cashions Creek Limestone, Benjamin Limestone and Westfield Sandstone in the Florentine Valley (see fig.1.2); the Chudleigh Limestone in the Mole Creek area (Northern Tasmania); and the Precipitous Bluff Beds and Prion Beach Beds from southernmost Tasmania, are dealt with in this study.

FIGURE 1.1

Location of known outcrops of Denison Subgroup and Gordon Subgroup rocks, or correlates thereof, in Tasmania. Areas of particular importance are indicated by name.


145
146
147
148
41
42
43
Eugenana
Railton
Mole Creek
Florentine Valley
Precipitous Bluff
N
GORDON SUB-GROUP
DENISON SUB-GROUP AND CORRELATES
0
50
100km
from Banks & Burrett 1980

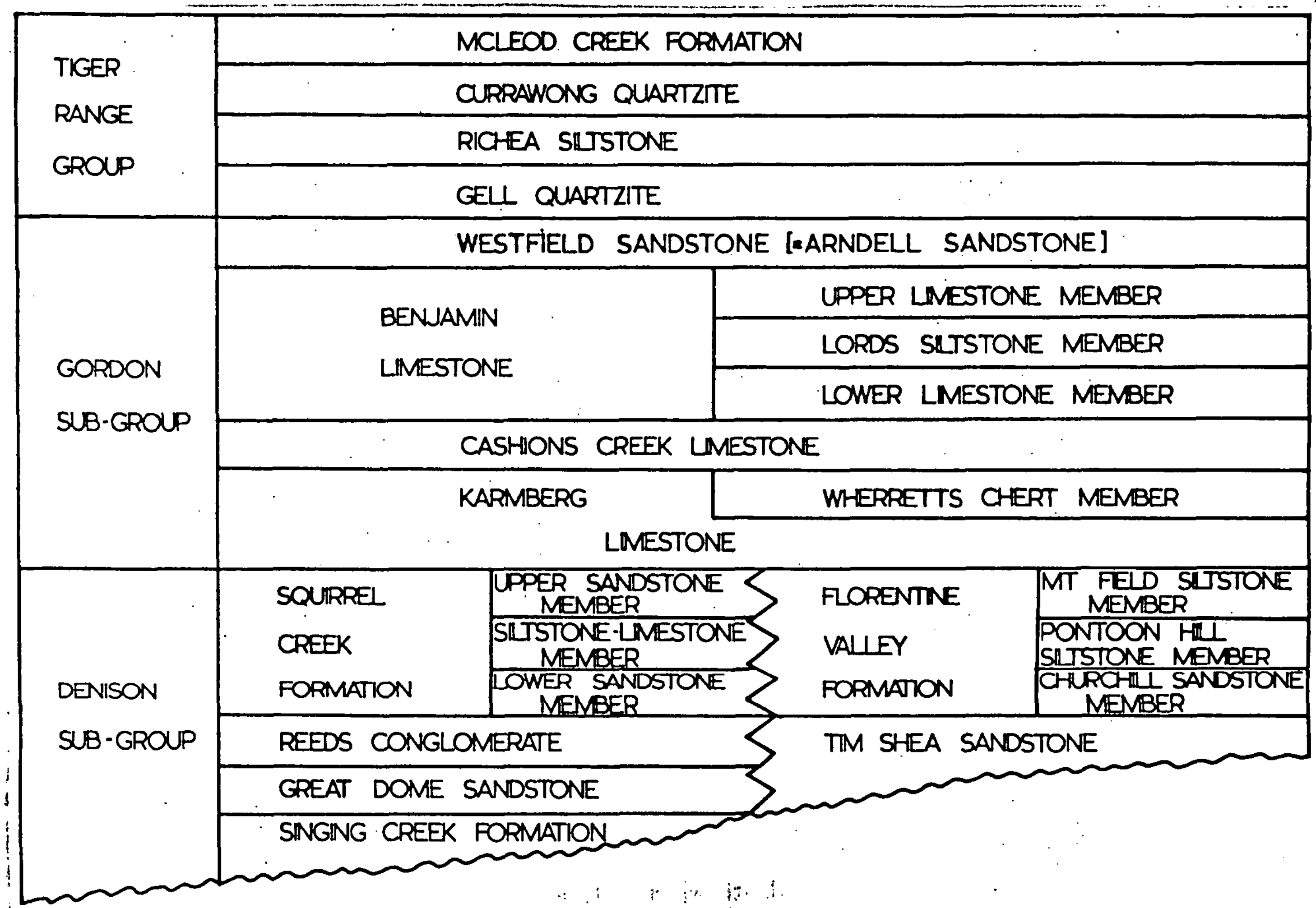
METHODS

The brachiopods found in the rocks of the Denison Subgroup are preserved as moulds whereas in the rocks of the Gordon Subgroup either the original shelly material remains or has been replaced by microcrystalline silica.

To obtain data on the cardinalia of specimens preserved as moulds, replicas were made using pre-vulcanised latex (Revultex, manufactured by Bellman Carter Ltd of London). This latex solution will not "take" on dry rock, therefore the surface was at first saturated with water. With rocks of a very low porosity the preliminary "wetting" was accomplished more rapidly by a 1:1 acetone-water solution. The "wetting" was then continued with addition of water, to dilute the acetone as much as possible (acetone makes the latex precipitate prematurely). After sufficient dilution of acetone had been achieved the pre-vulcanised latex was added, at first sparingly, to assure maximum diffusion without trapping any air or water pockets.

Because of considerable decrease in volume with drying, additional layers of latex were added at regular intervals (every 1 or 2 hours) until a sufficient thickness was achieved such that shrinkage hollows in the exposed surface did not extend close enough to the replicated surface to cause damage upon removal of the solidified latex.

FIGURE 1.2
Stratigraphy of the Denison Subgroup, Gordon Subgroup and Tiger Range Group in their type areas in and near the Florentine Valley. Based on the work of Corbett & Banks (1974, 1975), Corbett (1975), Baillie (1979) and Stait & Laurie (1980).


TIGER RANGE GROUP
MCLEOD CREEK FORMATION
CURRAWONG QUARTZITE
RICHEA SILTSTONE
GELL QUARTZITE
GORDON SUB-GROUP
WESTFIELD SANDSTONE [=ARNDELL SANDSTONE]
BENJAMIN LIMESTONE
UPPER LIMESTONE MEMBER
LORDS SILTSTONE MEMBER
LOWER LIMESTONE MEMBER
CASHIONS CREEK LIMESTONE
KARMBERG LIMESTONE
WHERRETTS CHERT MEMBER
DENISON SUB-GROUP
SQUIRREL CREEK FORMATION
UPPER SANDSTONE MEMBER
SILTSTONE-LIMESTONE MEMBER
LOWER SANDSTONE MEMBER
FLORENTINE VALLEY FORMATION
MT FIELD SILTSTONE MEMBER
PONTOON HILL SILTSTONE MEMBER
CHURCHILL SANDSTONE MEMBER
REEDS CONGLOMERATE
TIM SHEA SANDSTONE
GREAT DOME SANDSTONE
SINGING CREEK FORMATION

The silicified specimens were etched from the limestone in a 10% v/v solution of acetic acid or hydrochloric acid. The insoluble residue (including silicified fossils) was then sieved and washed gently for about 5 minutes to prevent crystallisation of salts upon drying. The sieves and their contents were then dried and the brachiopods removed using tweezers formed from thin flexible cardboard. These utensils could exert enough pressure to grip specimens but rarely was the pressure sufficient to cause specimen damage. What little insoluble residue remained on the brachiopods was removed with a needle, the frayed apex of a triangle of cardboard or with a fine brush.

The specimens (moulds, latex casts or silicified specimens) were all prepared for photography in the same way. They were first given a uniform black coating and then the relief was highlighted with magnesium oxide.

Blackening of the specimens was accomplished using coarse fibre-tip marking pens which use a waterproof, alcohol based dye (for example Shachihata Artline and Texta Parcelmate). The dye reservoir was half filled with acetone and the pen shaken for a few seconds. When turned upright (in writing attitude), the dye laden acetone slowly drips off the end of the fibre tip onto the specimen. The acetone evaporates rapidly leaving a matt black covering over the specimen. If too much dye has been retained upon the specimen, a slight sheen may result, inhibiting photography. This sheen can be removed by bathing the specimen in acetone and if necessary, by using a brush to remove some of the excess dye.

Whitening of the specimens to accentuate relief was achieved by holding the specimen over a burning magnesium ribbon. The ribbon was hung down the centre of a conical metal funnel, with an aperture of about 1 cm diameter at the apex. The cone acts as a shield to prevent eye damage and as a means of accentuating the updraught.

Upon ignition of the ribbon the specimen is passed quickly through the stream of suspended magnesium oxide powder several times at a height of from 50 to 70 mm above the apex of the funnel. Higher than this and problems were encountered with accretion of rapidly cooling magnesium oxide into stringers and globules.

Photography of the specimens was accomplished using Ilford FP4 film in a Wild M400 Photomakroskop (with additional 0.5x and 2.0x objective lenses) attached to a Wild MPS 55 Photoautomat. Lighting was obtained from two Volpi Intralux 150H light sources, one having a 4 point optical fibre ring illuminator, the other with twin optical fibre swan-necks. The ring illuminator was attached to the objective lens of the M400 and the swan-necks were located for top-right illumination at an elevation of 30^{o}-50^{o} and at a distance of 100 to 120 mm from the specimens.

TAXONOMIC PRINCIPLES

One of the greatest problems encountered during this study was insufficient characterisation of previously described species. This manifested itself in three forms; firstly, insufficient quality and quantity of illustration; secondly, insufficient detail of verbal description and finally, insufficient statistical data.

Systematic descriptions are now usually accompanied by measurements of the holotype and occasionally of one or more paratypes. However, as Temple (1968, p.4) states, "quantitative comparison with previously described species can be made only on the basis of adequate topotype collections, and it is unfortunately true that in the great majority of cases such collections do not exist - indeed many previously described species ..... are based on a single preserved specimen ...... It is difficult to specify the minimum size of sample adequate for comparative purposes, but one of fewer than ten specimens is almost certainly too small to give reasonably precise estimates of mean values and dispersion on which comparisons can be based".

The author has attempted in this study to circumvent the above shortcomings by providing adequate illustration description and statistical data for each species.

PREVIOUS WORK

The work of previous investigators into the areal geology, stratigraphy and sedimentology will be dealt with in the introductions to the relevant geographical areas while a discussion of previous palaeontological investigations can be found in the introduction to the systematic palaeontology section.

ACKNOWLEDGEMENTS

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CHAPTER TWO

FLORENTINE VALLEY AREA

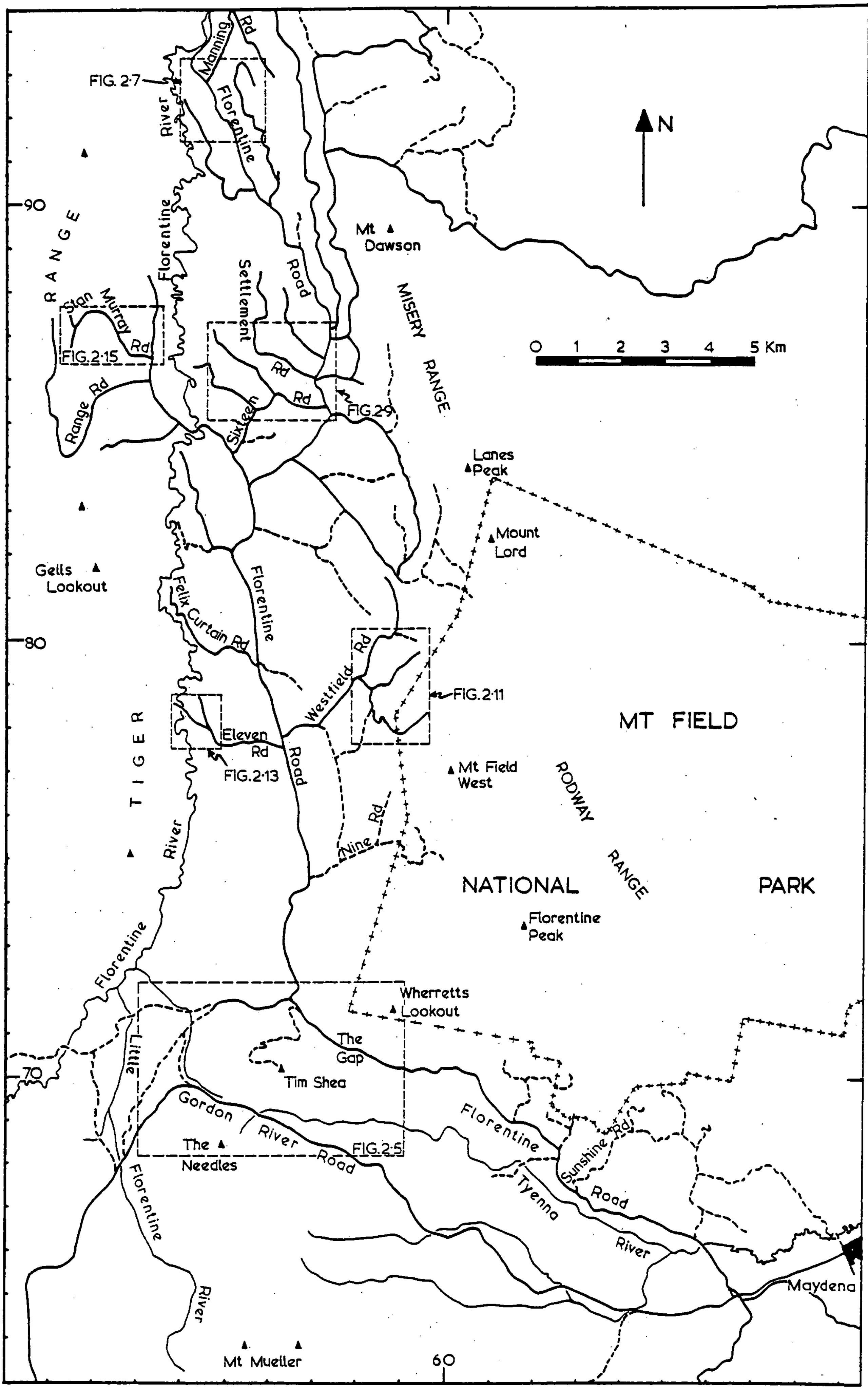
INTRODUCTION

The Florentine Valley is a broad meridional valley located in central southern Tasmania (see fig. 1.1), northwest of the township of Maydena which lies 66 kilometetres by road west-northwest of Hobart. The valley (see fig. 2.1) forms part of a logging concession granted to Australian Newsprint Mills Ltd. The logging operations and subsequent undergrowth clearing and burning (for regeneration purposes) has given access to nearly complete sections through portions of the Gordon Subgroup. West of Maydena, on the margins of the Florentine Valley construction of the Gordon River Road by the Tasmanian Hydro-Electric Commission has created excellent sections through the upper units of the Denison Subgroup. These sections in and around the Florentine Valley form the basis of this study.

PREVIOUS WORK

Apart from several reports of limestone in the vicinity and the description by Etheridge (1904) of some trilobites collected by T. Stephens, very little was known of the geology of the Florentine Valley area until Twelvetrees' expedition in 1908. He correctly

Figure 2.1. Locality map of Florentine Valley area. Rectangular areas outlined by dashed line are enlarged in subsequent diagrams.



N
0 1 2 3 4 5 Km
FIG. 2·7
Manning Rd
Florentine
River
90
RANGE
Florentine
Mt Dawson
Settlement
Road
MISERY RANGE
Stan Murray Rd
FIG. 2·15
Range Rd
Rd
Rd
Sixteen
FIG. 2·9
Lanes Peak
Mount Lord
Gells Lookout
Felix Curtain Rd
Florentine
80
Rd
Westfield
FIG. 2·11
MT FIELD
TIGER
Eleven Rd
FIG. 2·13
Road
Mt Field West
RODWAY RANGE
Rd
Nine
River
NATIONAL
PARK
Florentine Peak
Florentine
Wherretts Lookout
The Gap
70
Little
Tim Shea
Gordon River Road
Florentine
Sunshine Rd
The Needles
FIG. 2·5
Road
Tyenna
Florentine
River
Maydena
River
Mt Mueller
60

interpreted the broad synclinal structure of the area, assigning the limestones to the Lower Silurian (ie. Ordovician of present usage) and the clastics forming the Denison Ranges and the flanks of Tim Shea to the Cambrian. The conglomerates and sandstones capping Tim Shea were incorrectly assigned a Permo-Carboniferous age.

Hills (1921) recognised the Silurian sandstone and siltstone sequence of the Tiger and Gordon Ranges. Nye (1929) in an account of the osmiridium deposits at Adamsfield correctly interpreted the relationships of the main formations. "He (Nye) recognised the Cambro-Ordovician slates and cherts west of Adamsfield, and the unconformable relationship with the overlying conglomerates. He correlated these with the 'West Coast Range Conglomerate Series', and the overlying limestone with the 'Gordon River Limestone Series', then thought to be Silurian" (Corbett & Banks 1974,p.211).

Lewis (1940), in the Tim Shea-Maydena (Tyenna) area, proposed the term "Junee Series" to include quartzites and conglomerates overlain by yellow mudstones which in turn were overlain by "Blue Junee limestone". The "yellow mudstones" contained "trilobites and other fossils of Lower (sic) Ordovician age". Lewis also correlated his Ordovician "Junee limestones" with those at Adamsfield (Nye 1929) but assumed the Gordon River Limestone to be a separate limestone sequence of Silurian age.

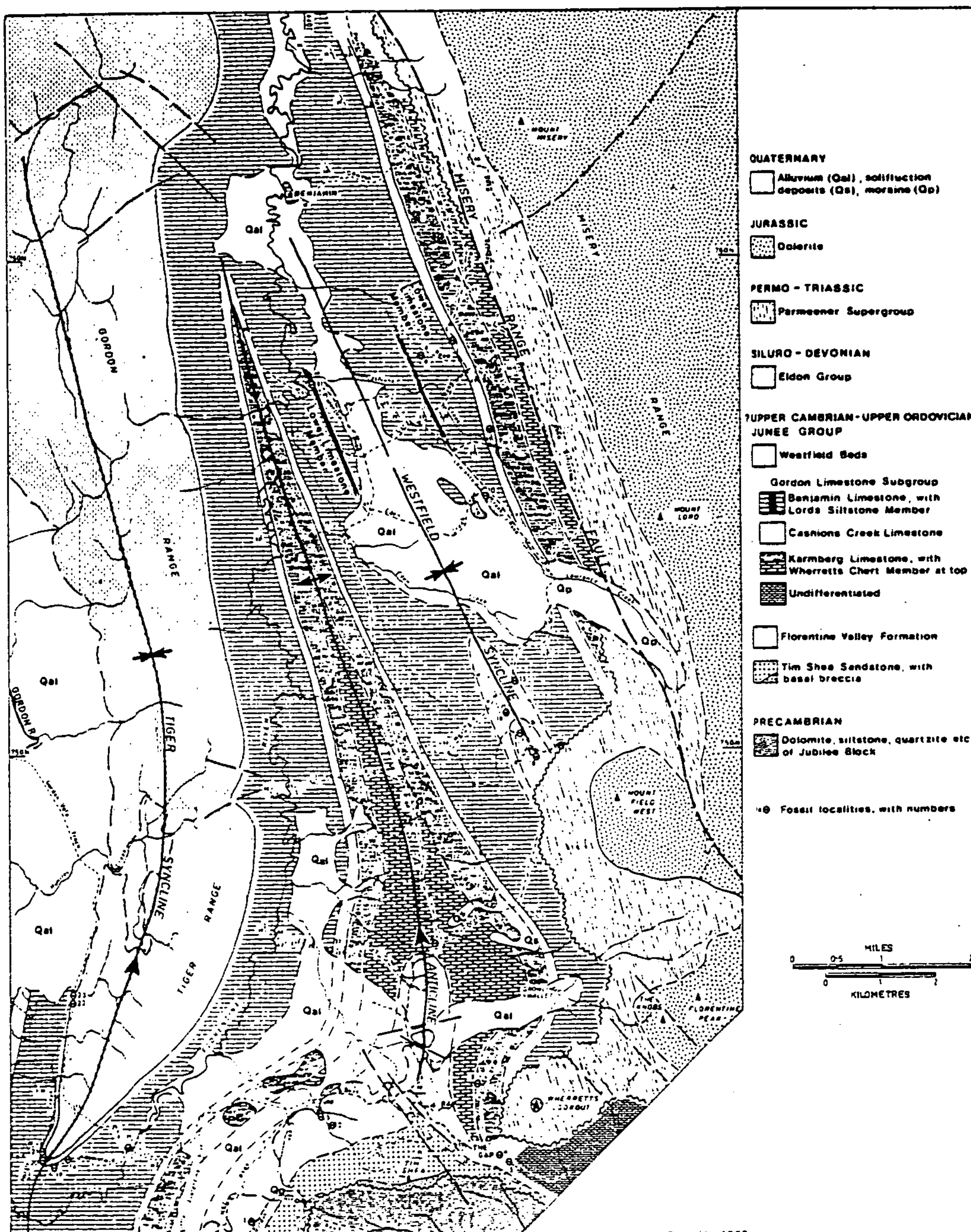
Carey and Banks (1954) clarified structural relationships near the southern end of the Florentine Valley, defining the Tyennan unconformity between the conglomerate on Tim Shea and the underlying Precambrian dolomites.

Jennings (1955) mapped the northern extremities of the Florentine Valley and the Vale of Rasselas (Valley of the Gordon River) on a regional scale.

Banks (1957) reviewed the palaeontological data on the Ordovician Junee Group, and later (Banks 1962) in a detailed review of the stratigraphy redefined the Florentine Valley Formation (Lewis' (1940) "yellow mudstone") and the Gordon Limestone on the eastern margin of the Florentine Valley. Further palaeontological data were also discussed.

Corbett (1963 unpubl.) produced the first detailed geological map of the Florentine Valley. The results of these investigations, along with more detailed palaeontological data were discussed by Corbett and Banks (1974). They also presented a revised geological map of the valley area (see fig. 2.2). In this work the "Gordon Limestone" was raised to subgroup level within the Junee Group and subdivided into three eminently mappable formations (see figure 2.3 for Corbett and Banks 1974 terminology of Junee Group).

Figure 2.2. Geological map of Florentine Valley area. From Corbett & Banks 1974.



QUATERNARY
Alluvium (Qal), solifluction deposits (Qs), moraine (Qp)
JURASSIC
Dolerite
PERMO - TRIASSIC
Parmeener Supergroup
SILURO - DEVONIAN
Eldon Group
?UPPER CAMBRIAN - UPPER ORDOVICIAN
JUNEE GROUP
Westfield Beds
Gordon Limestone Subgroup
Benjamin Limestone, with Lords Siltstone Member
Cashions Creek Limestone
Karmberg Limestone, with Wherretts Chert Member at top
Undifferentiated
Florentine Valley Formation
Tim Shea Sandstone, with basal breccia
PRECAMBRIAN
Dolomite, siltstone, quartzite etc of Jubilee Block
Fossil localities, with numbers
MILES
KILOMETRES
GORDON
RANGE
TIGER
SYNCLINE
TIGER RANGE
WESTFIELD
SYNCLINE
MISERY
RANGE
FAULT
ANTICLINE
Qal
Qp
Qs
Modified after Corbett, 1963

Brown _et al_.(1975) asserted that Corbett and Banks (1974) had introduced a dubious correlation (ie. the inclusion of the Reeds Conglomerate, a unit occurring 24 km west of the area under consideration) into the definition of the basal portion of the Junee Group.

Corbett and Banks (1975) replied by making the term "Junee Group" redundant. This was done by redefining the Gordon Subgroup to include the Westfield Beds and incorporating the clastics below the limestones into the Denison Sub-group of Corbett (1975) (see fig. 2.4).

More recently, Baillie (1979) in studying the sequence of the Tiger Range, erected the Tiger Range Group for the Silurian to ?Lower Devonian sequence overlying the Gordon Subgroup, the uppermost formation of the latter being formally designated the Arndell Sandstone (= Westfield Beds sensu Corbett and Banks).

Stait and Laurie 1980 (see appendix 1) have discussed the lithostratigraphy and biostratigraphy of the Florentine Valley Formation. The formation was divided into three members, the lateral extent of which is open to question because of generally poor outcrops of the formation as a whole.

The present terminology of rock units in and around the Florentine Valley is shown in fig. 1.2.

Figure 2.3. Stratigraphy of Junee Group.

From Corbett & Banks 1974.

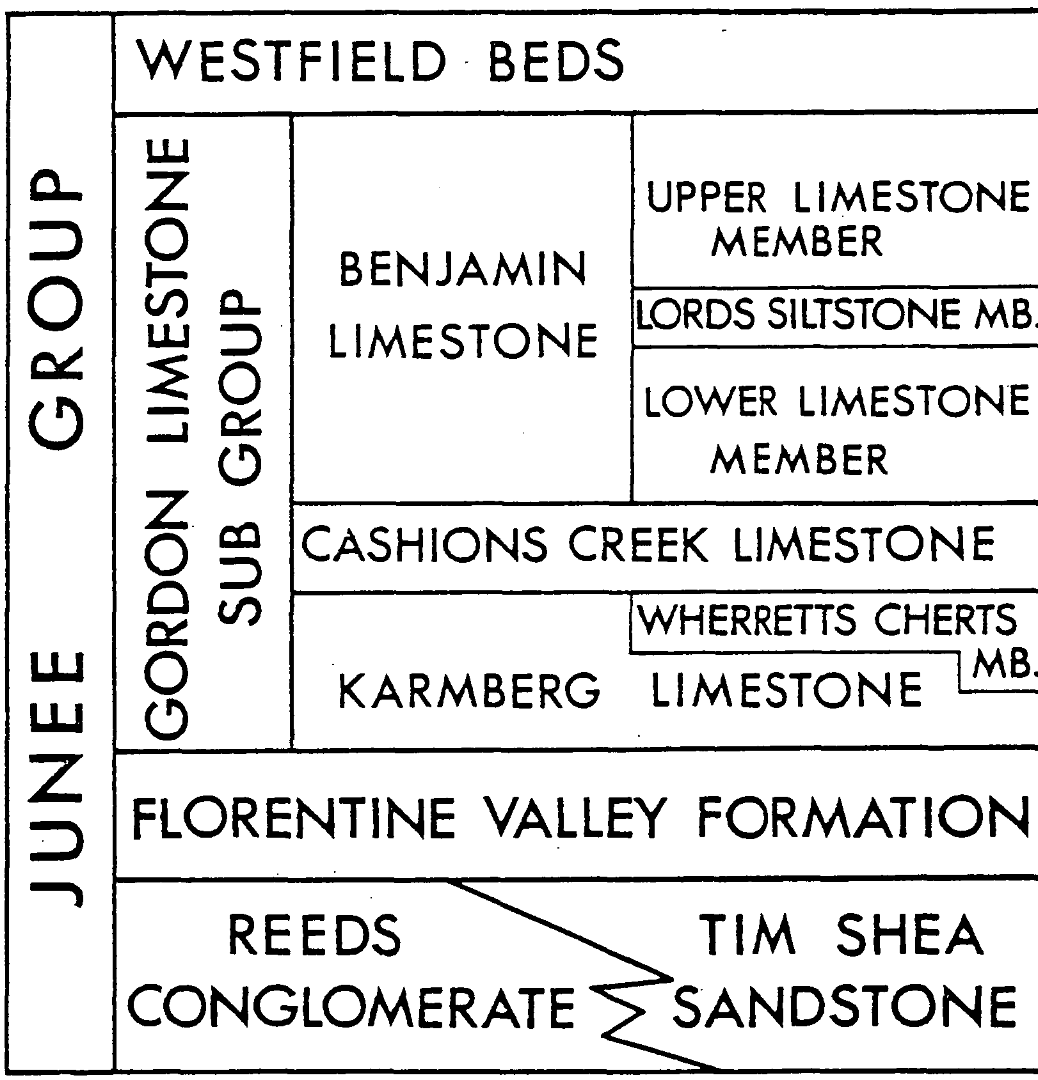
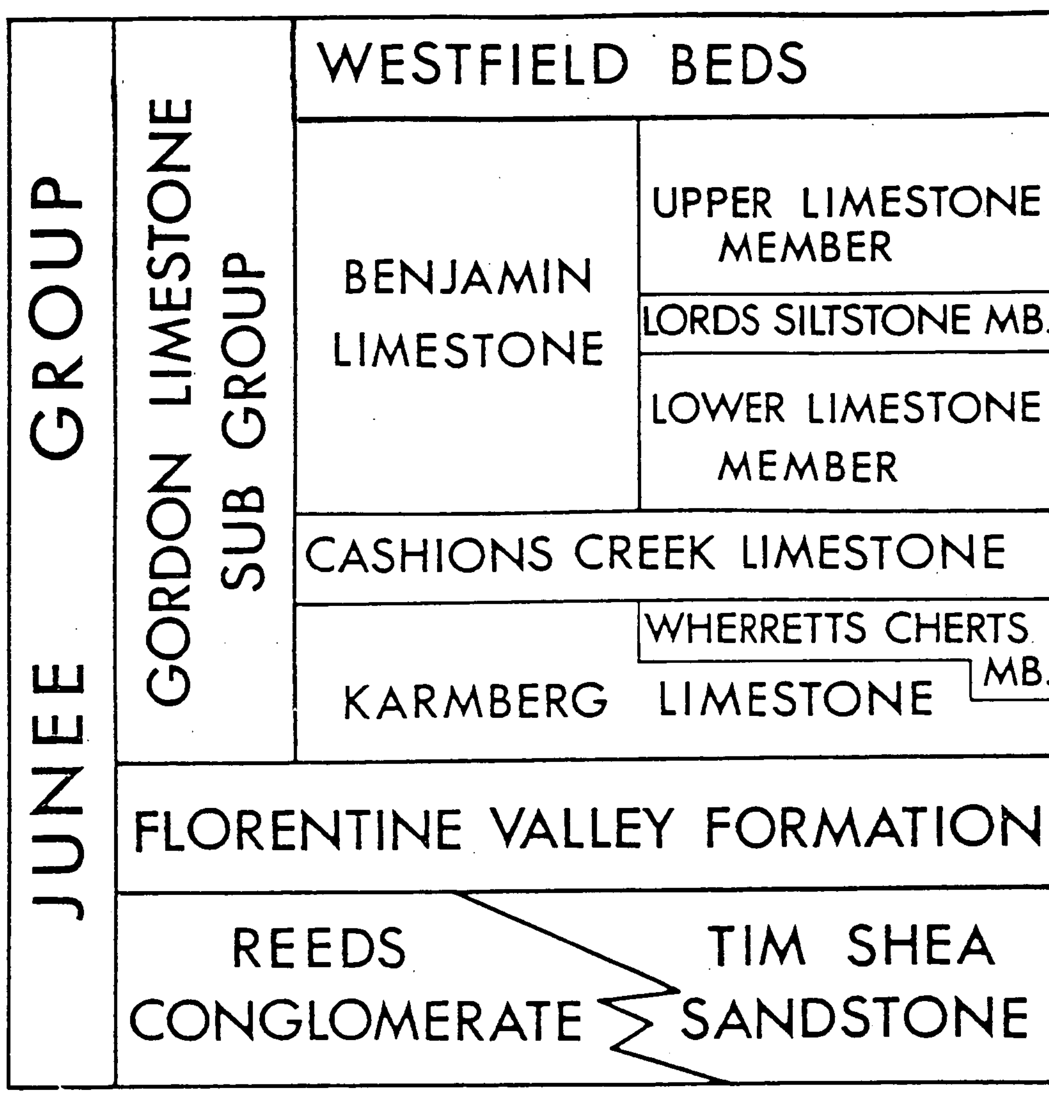

JUNEE GROUP
WESTFIELD BEDS
GORDON LIMESTONE SUB GROUP
BENJAMIN LIMESTONE
UPPER LIMESTONE MEMBER
LORDS SILTSTONE MB.
LOWER LIMESTONE MEMBER
CASHIONS CREEK LIMESTONE
WHERRETTS CHERTS MB.
KARMBERG LIMESTONE
FLORENTINE VALLEY FORMATION
REEDS CONGLOMERATE
TIM SHEA SANDSTONE

Figure 2.4. Revised stratigraphy of Junee Group. From Corbett & Banks 1975.


JUNEE GROUP
GORDON LIMESTONE SUB GROUP
WESTFIELD BEDS
BENJAMIN LIMESTONE
UPPER LIMESTONE MEMBER
LORDS SILTSTONE MB.
LOWER LIMESTONE MEMBER
CASHIONS CREEK LIMESTONE
WHERRETTS CHERTS MB.
KARMBERG LIMESTONE
FLORENTINE VALLEY FORMATION
REEDS CONGLOMERATE
TIM SHEA SANDSTONE

LITHOSTRATIGRAPHY

Tim Shea Sandstone

This name was erected by Twelvetrees (1908, p27) for the "finegrained conglomerate alternating with coarse sandstone and grit and a few beds of coarser conglomerate" exposed at the summit of Tim Shea. Corbett and Banks redefined the unit as "that formation of red to grey quartzose sandstone with minor conglomerate and red siltstone exposed on the crest and northern slopes of Tim Shea and on the cuesta ridges to the southwest". Corbett and Banks (op. cit.) also noted that locally derived breccias were developed at the base in some areas.

The formation is variable in thickness the maximum being at Tim Shea where it is about 300 metres thick. It is separated from the underlying Precambrian dolostones by the Tyennan unconformity (Carey and Banks 1954).

The formation is only poorly fossiliferous, containing probable worm burrows and scattered, poorly preserved gastropods and will therefore be discussed no further.

Florentine Valley Formation

Etheridge (1904, p101) used the term "Florentine

Valley Beds" when discussing the age of rocks from which a collection of trilobites had come. Lewis (1940) used the name "Junee mudstone" for beds overlain conformably by the "blue Junee Limestone". These "Junee mudstones" provided the fossils described by Kobayashi (1940a) and, Lewis believed, those described by Etheridge (op. cit.). Brown (1948, p39), in a description of an early Ordovician brachiopod fauna, used the term "Junee beds" for this same unit. Banks (1957, p41) resurrected the term Florentine Valley Mudstone and gave a faunal list but no detailed lithological data.

Corbett and Banks (1974, p217) defined the Florentine Valley Formation as "that formation of sandstones and siltstone with lesser limestone and chert which conformably overlies the Tim Shea Sandstone ... and underlies the Gordon Limestone Subgroup". They designated no type section but noted that the formation is best exposed on the Gordon Road northwest of the Needles, on the Florentine Road at the Gap, and in Squirrel Creek in the northern Rasselas Valley. This last occurrence provided the type section for the Squirrel Creek Formation in Corbett's (1975) description of the Cambro-Ordovician sequence of the Denison Ranges. For further discussion of the lithostratigraphy (and biostratigraphy) of the Florentine Valley Formation see "Lithostratigraphy and Biostratigraphy of the Florentine

Valley Formation in the Tim Shea area, southwest Tasmania" by Stait & Laurie (1980) (appendix 1). A more detailed locality map of the sections studied, than that presented in the appendix is given in fig. 2.5.

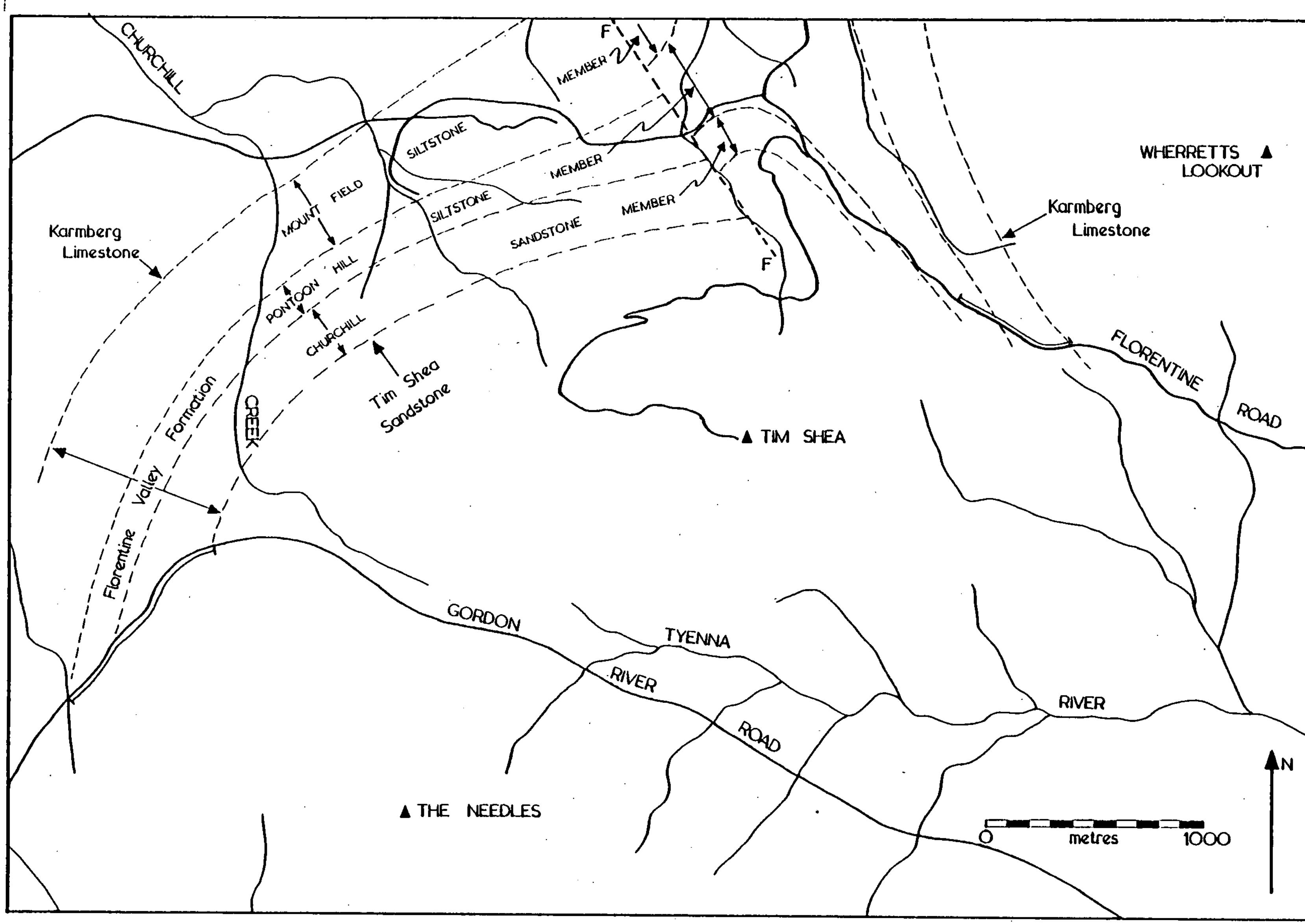
Karmberg Limestone

The Karmberg Limestone was defined by Corbett and Banks (1974, p220) as "that formation of impure limestone and chert-rich limestone lying between the Florentine Valley Formation below and the Cashions Creek Limestone above". They again designated no type section but noted that the "best exposures are on the lower northern slopes of Wherrett's Lookout and along Nine Road from its junction with the main Florentine Road..".

The total thickness was estimated to be about 450 metres, with the uppermost 150 metres (in parts of the Florentine Valley) consisting of chert-rich limestone referred to as the Wherretts Chert Member. This member has not been recognised in the Rasselas Valley and is very weakly developed in the northern reaches of the Florentine Valley.

Of the sections mentioned by Corbett and Banks (1974) the exposures near Wherretts Lookout are now overgrown and largely inaccessible and the section along Nine Road (see fig. 2.1) has been severely weathered

Figure 2.5. Location of sections of Florentine Valley Formation along the Gordon River Road and at the Gap. The lithostratigraphy of these sections are dealt with in Stait & Laurie 1980 (see appendix 1).


CHURCHILL
MEMBER 2
F
SILTSTONE
MEMBER
SILTSTONE
MEMBER
SANDSTONE
MOUNT FIELD
PONTOON HILL
CHURCHILL
WHERRETTS
LOOKOUT
Karmberg
Limestone
Karmberg
Limestone
Tim Shea
Sandstone
Florentine Valley Formation
CREEK
TIM SHEA
FLORENTINE ROAD
GORDON RIVER ROAD
TYENNA RIVER
THE NEEDLES
0 metres 1000
N

leaving only several scattered outcrops. Other sections through the Karmberg Limestone (or part thereof) are found along Sunshine Road (see fig. 2.1); across the Florentine Road just south of Manning Road turnoff (see fig. 2.7) and along Florentine Road at the Gap (see fig. 2.1). The Sunshine Road and Manning Road sections have provided most of the data about the formation and its faunas whilst supplementary data on faunas has been obtained from the section along the Florentine Road at the Gap and the outcrops remaining along Nine Road.

The section of the Karmberg Limestone along Sunshine Road is here selected as the type section with the base of the Karmberg Limestone in this section being defined at the base of the lower lenticular body of nodular limestone. This occurs at Grid Reference 642687 (Tyenna 1:100 000 Sheet).

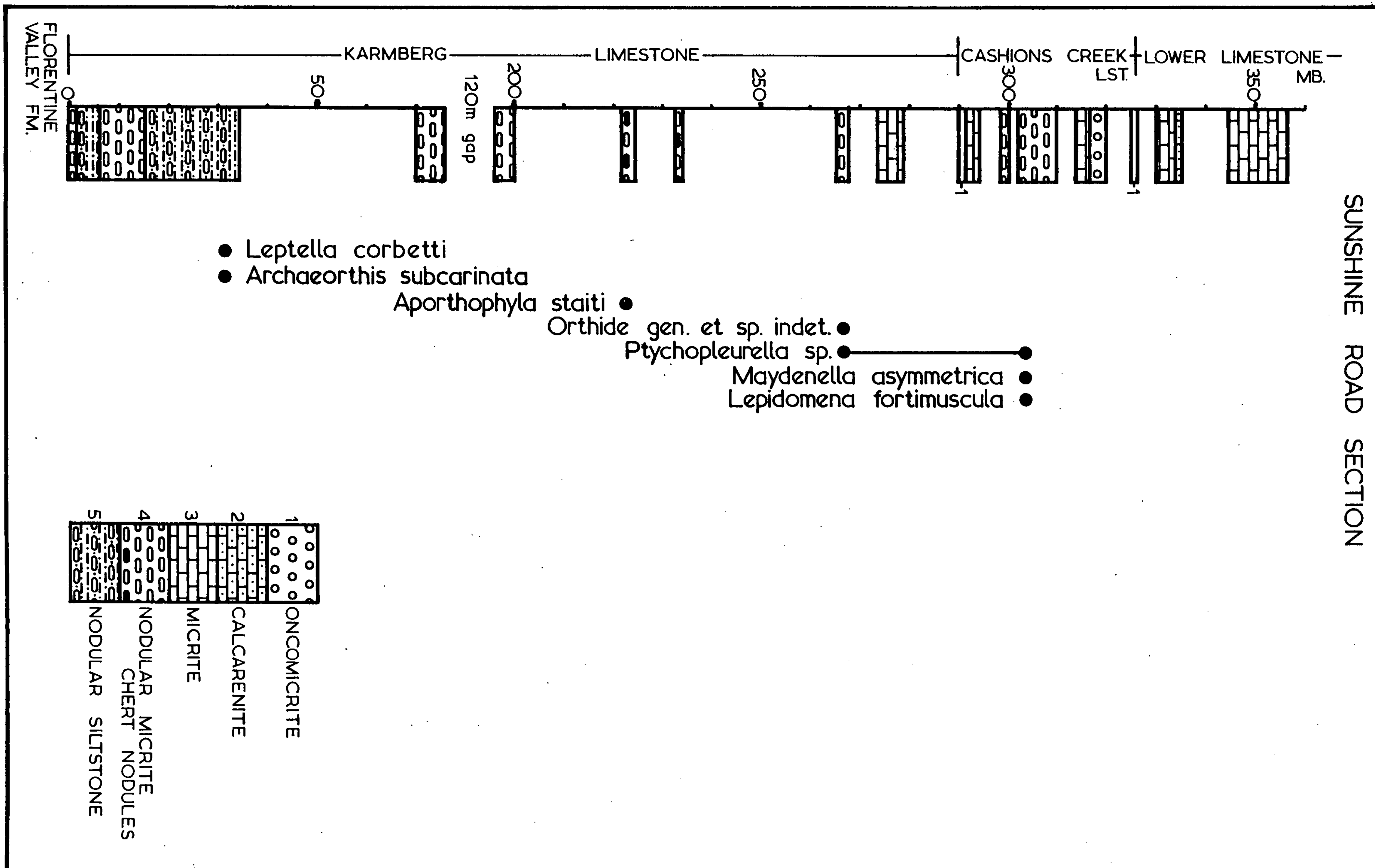
The top of the formation is defined as the base of the lowest oncolitic limestone (ie oncolites $>$5% of rock volume). This is an arbitrary boundary as the transition between the Karmberg Limestone and the overlying oncolitic Cashions Creek Limestone is largely gradational. The top of the Karmberg Limestone along Sunshine Road is found at grid Reference 645693 (Tyenna 1:100 000 Sheet).

The Sunshine Road section with the ranges of included brachiopod species is presented graphically in fig 2.6. In this section, the Karmberg Limestone, at its base consists of nodular siltstones with apparently lenticular interbeds of nodular micrite. Above this the siltstones disappear and nodular micrite with scattered horizons containing irregular bodies of black chert occur. The nodules within the siltstones were probably calcareous but have now been de-calcified such that sometimes only cavities remain. If some sediment remains it is a very friable silty material. The nodular micrites consist of lenticular bodies (up to 150 mm long and rarely over 20 or 30 mm thick) of micrite separated from one another by brown siltstone stringers of variable thickness.

The Manning Road Section with its associated brachiopod ranges is presented graphically in fig 2.8. Here the unit, where exposed, consists of nodular siltstone, the nodules of the latter still retaining their $CaCO_3$.

Chert nodules are only rarely developed in the upper Karmberg Limestone in this section. Toward the top of the unit the siltstone stringers become narrower and more widely spaced and the micrite itself becomes more oncolitic, passing gradually into the lithology characteristic of the overlying Cashions Creek Limestone.

Figure 2.6. Sunshine Road section through Karmberg Limestone and Cashions Creek Limestone with associated brachiopod ranges. The small numbers to the right of the stratigraphic column represent lithological types, the key being in the lower right hand corner of the diagram. Thicknesses, to the left of the column are in metres. Sunshine Road is located south of Mt Field National Park (see fig. 2.1).


FLORENTINE VALLEY FM.
KARMBERG LIMESTONE
CASHIONS CREEK LST.
LOWER LIMESTONE MB.
0
50
120m gap
200
250
300
350
1
1
Leptella corbetti
Archaeorthis subcarinata
Aporthophyla staiti
Orthide gen. et sp. indet.
Ptychopleurella sp.
Maydenella asymmetrica
Lepidomena fortimuscula
5
4
3
2
1
NODULAR SILTSTONE
NODULAR MICRITE CHERT NODULES
MICRITE
CALCARENITE
ONCOMICRITE
SUNSHINE ROAD SECTION

The section along the Florentine Road at the Gap outcrops poorly and some portions are repeated along the winding road and exact relationships are unknown.

Cashions Creek Limestone

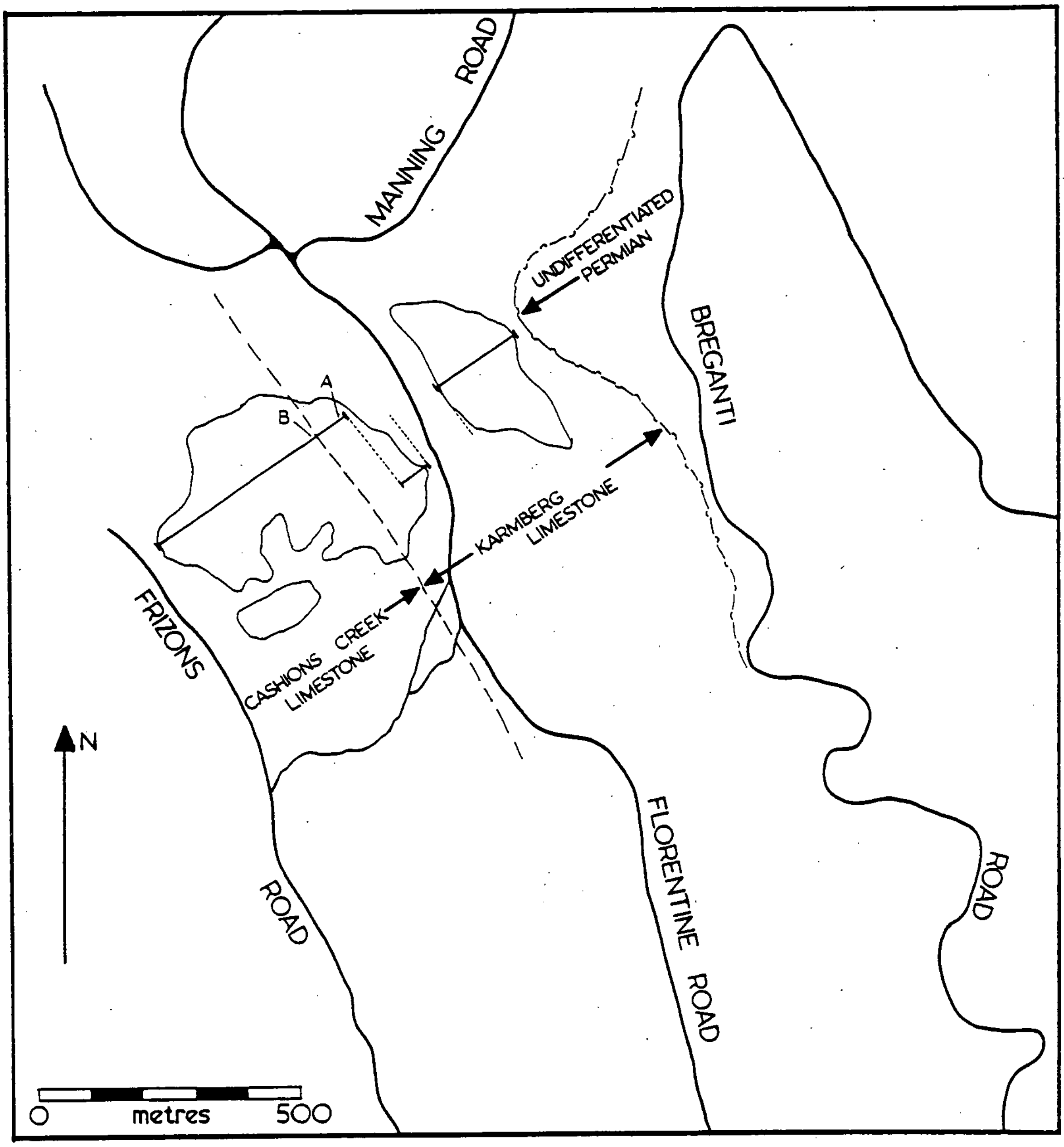
This formation was defined by Corbett and Banks (1974 p221) as "that formation of thick-bedded dolomitic limestone containing abundant Girvanella colonies (sic) which forms a prominent strike ridge in many areas.... The thickness of the formation was estimated to be of the order of 150 metres.

Again no type section was given but an area of good exposure was designated. This however has now been overgrown and the outcrop largely obscured.

Other sections through all or part of this unit are found between the end of Felix Curtain Road and the Florentine River, (see fig. 2.1) west of Florentine Road south of Manning Road turnoff (see fig. 2.7), along Settlement Road (see fig. 2.9) and along Sunshine Road (see fig. 2.1).

The sections of the Cashions Creek Limestone along Settlement Road and to the west of Florentine Road, south of Manning Road turnoff, have provided most information about the formation and its faunal content. At Felix Curtain Road the formation outcrops well but

Figure 2.7. Location of Manning Road section through Karmberg Limestone and Cashions Creek Limestone. Numbered and lettered points in this and following locality maps refer to type localities of particular brachiopod species.


MANNING ROAD
UNDIFFERENTIATED PERMIAN
BREGANTI
A
B
KARMBERG LIMESTONE
CASHIONS CREEK LIMESTONE
FRIZONS ROAD
FLORENTINE ROAD
ROAD
N
0 metres 500

silicified faunas are found only in the topmost beds. Along Sunshine Road the formation is very thin and not very fossiliferous.

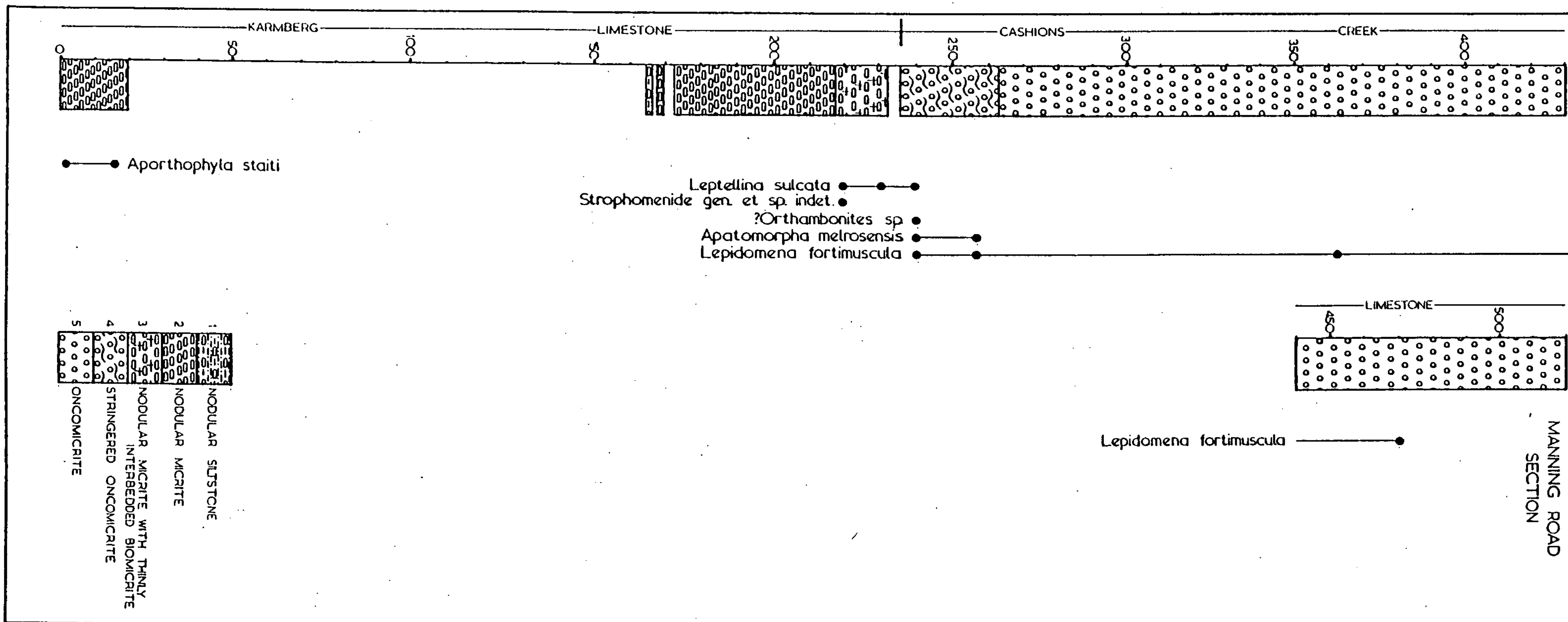
The lower boundary of the Cashions Creek Limestone, as used herein is arbitrarily defined to occur at the base of the lowest unit in which oncolites constitute more than 5% of the rock. The upper boundary is similarly defined.

The section along Settlement Road, with its associated brachiopod ranges is presented graphically in fig 2.10a. Here, only the top half of the formation outcrops. It consists mainly of oncolitic calcarenite with occasional thin units of micrite, biosparite and biopelsparite occurring near the top of the formation.

The section along Sunshine Road with its associated brachiopod ranges is presented graphically in fig 2.6. Here the unit, although outcropping relatively well, is thin and the lithology quite different to that characteristic of the unit elsewhere. Oncolitic calcarenites form only a small proportion of the formation, by far the largest proportion being massive micrites and nodular micrites.

The Manning Road section with associated brachiopod ranges is presented in fig 2.8. The top of the formation is not exposed in this section, and boundary

Figure 2.8. Manning Road section through Karmberg Limestone and Cashions Creek Limestone, with associated brachiopod ranges.



KARMBERG
LIMESTONE
CASHIONS
CREEK
LIMESTONE
0
50
100
150
200
250
300
350
400
450
500
Aporthophyla staiti
Leptellina sulcata
Strophomenide gen. et sp. indet.
?Orthambonites sp.
Apatomorpha melrosensis
Lepidomena fortimuscula
Lepidomena fortimuscula
1 NODULAR SILTSTONE
2 NODULAR MICRITE
3 NODULAR MICRITE WITH THINLY INTERBEDDED BIOMICRITE
4 STRINGERED ONCOMICRITE
5 ONCOMICRITE
MANNING ROAD SECTION

between the Karmberg Limestone and Cashions Creek Limestone is gradational. At its base the Cashions Creek Limestone consists of an oncolitic calcarenite with stringers of silty material. These stringers are reminiscent of those in the nodular micrites of the Karmberg Limestone, but are nowhere as thick or as densely packed as those of the latter. The remainder of the exposure of the formation in this section consists almost entirely of oncolitic calcarenite.

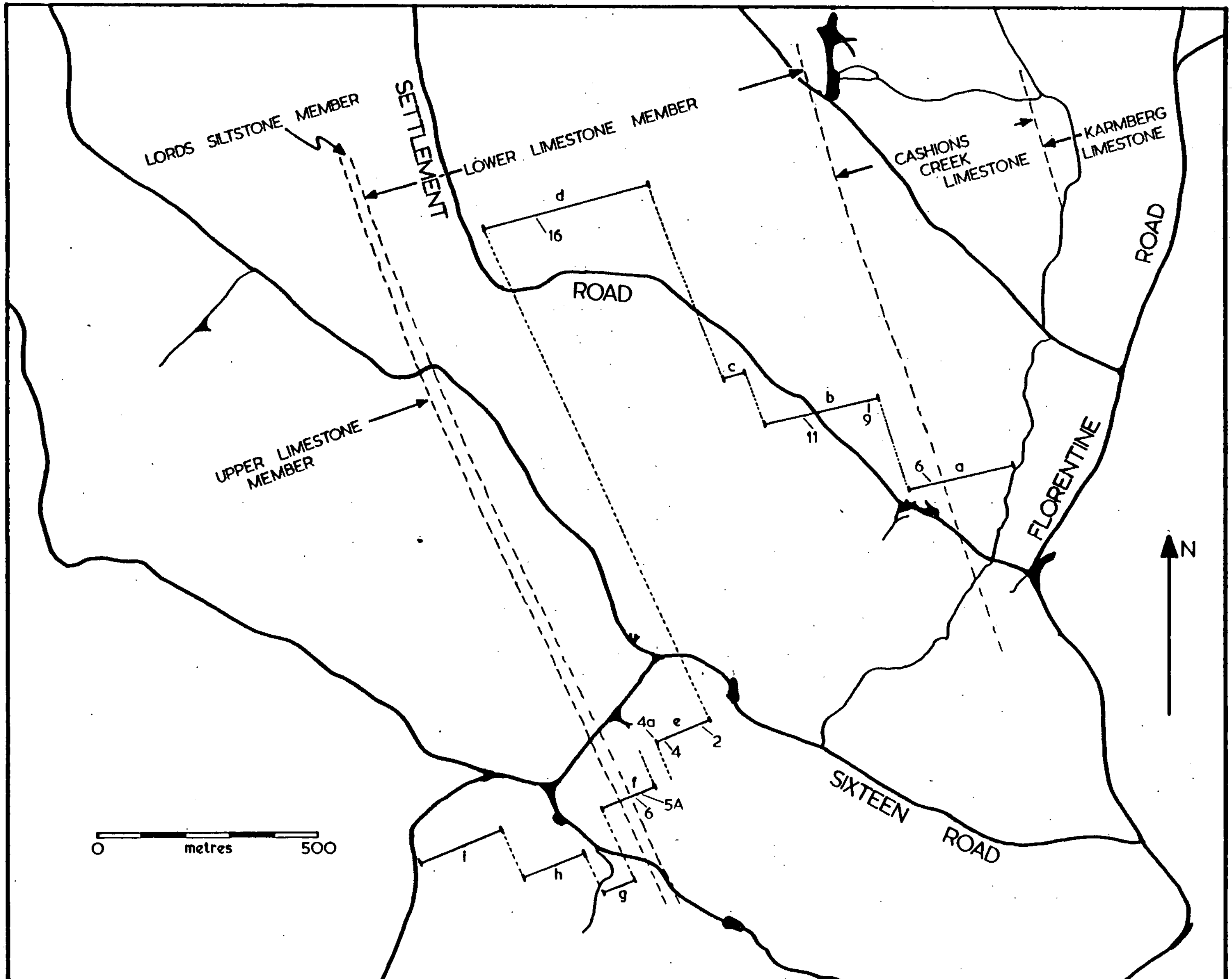
Benjamin Limestone

This formation was erected by Corbett and Banks (1974, p.223) and defined as "that formation of limestone and minor siltstone lying between the Cashions Creek Limestone below and the siltstones and sandstones of the Westfield beds above". The thickness of the unit was calculated to be between 900 and 1200 metres. At the time no single type section was known but it was noted that the formation was well exposed along most of the western side of the valley.

Corbett and Banks subdivided the Benjamin Limestone into three members, a Lower Limestone Member (of 480 metres thickness) the medial Lords Siltstone Member (about 15 metres thick) and the Upper Limestone Member (of 600 to 700 metres thickness).

Recent work by Calver (1977, unpubl. hons thesis) and Page (1978, unpubl. hons thesis) on the palaeoecology and sedimentology of the Lower and Upper Limestone Member (respectively), has located a complete section through the Benjamin Limestone along a southern branch road from Westfield road (see fig. 2.11) and other good, though incomplete, sections along Settlement Road (see fig. 2.9) and Eleven Road (see fig. 2.13). The section along Westfield Road encompasses both Upper and Lower Limestone Members and a thin (5 metres) Lords Siltstone Member. In this section the lower Limestone Member consists mainly of massive micrite, biomicrite, horizontally-burrowed micrite, micrite with dolomitic stringers, with less common algal-laminated micrite, Tetradium boundstone, intrasparарenite, intrabiosparаrenite, birdseye micrite and rare vertically-burrowed micrite and oncolitic calcarenite. The Lords Siltstone Member consists of a pale brown micaceous siltstone and fine sandstone. The upper Limestone Member consists predominantly of massive micrite and biomicrite with lesser horizontally-burrowed micrite, micrite with dolomitic stringers, intrasparаrenite, intrabiosparаrenite with rare Tetradium boundstone, algal-laminated micrite, oncolitic calcarenite, birdseye micrite and siltstone. The Westfield section with its associated brachiopod ranges is presented graphically in fig. 2.12.

Figure 2.9. Location of Settlement Road section through Cashions Creek Limestone and Benjamin Limestone.

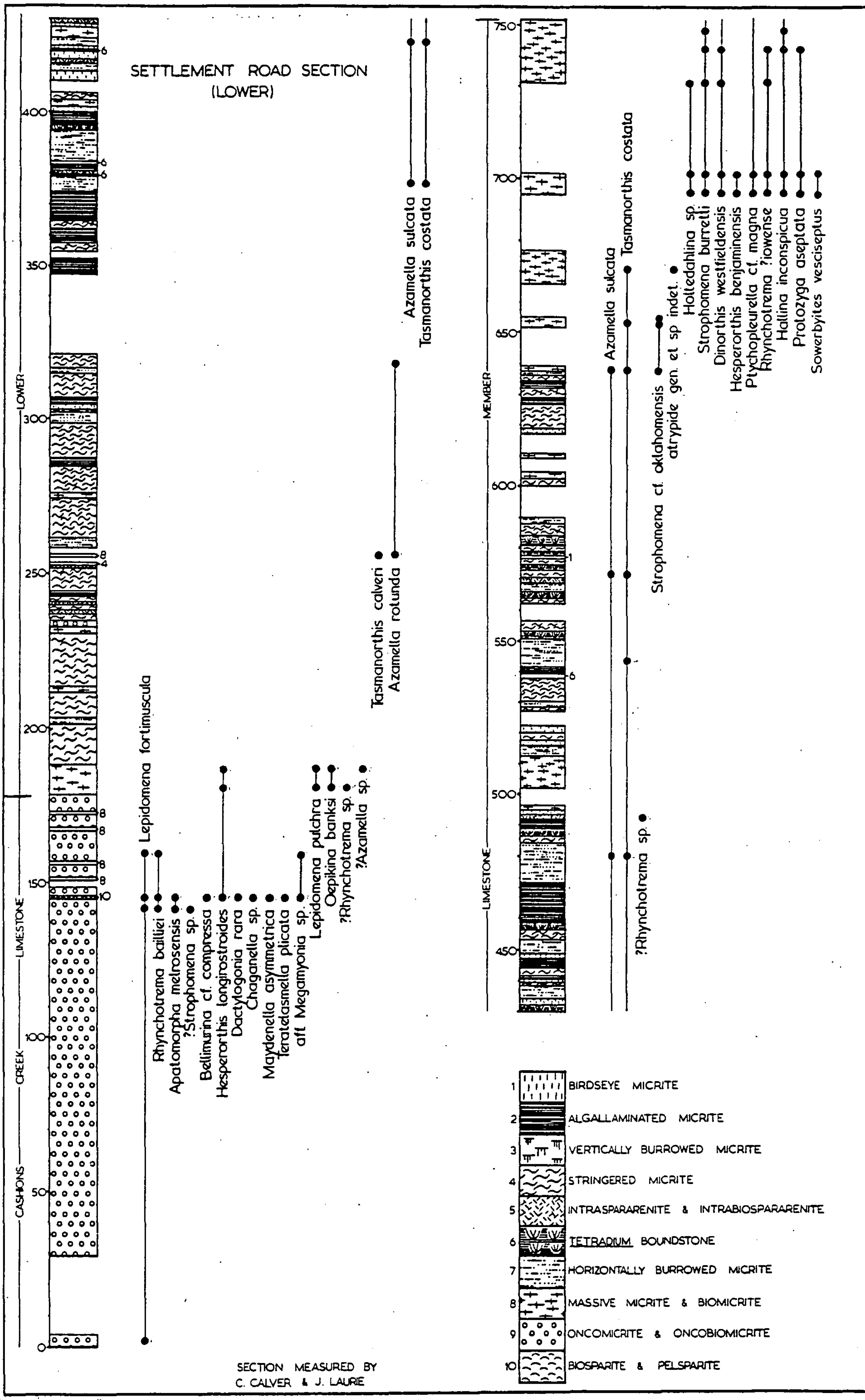


LORDS SILTSTONE MEMBER
SETTLEMENT
LOWER LIMESTONE MEMBER
ROAD
CASHIONS CREEK LIMESTONE
KARMBERG LIMESTONE
ROAD
FLORENTINE
UPPER LIMESTONE MEMBER
N
SIXTEEN ROAD
0 metres 500

The section along Settlement Raod encompasses both the Lower Limestone Member and the Lords Siltstone member (about 20 metres thick here) and part of the Upper Limestone Member. In this section the Lower Limestone Member consists mainly of micrite with dolomitic stringers, massive micrite, biomicrite, horizontally-burrowed micrite, algallaminated micrite with lesser _Tetradium_ boundstone, birdseye micrite, intraspararenite and intrabiospararenite with rare oncolitic calcarenite. The Lords Siltstone Member consists of pale brown, yellowish or orange micaceous siltstone and fine sandstone. The Upper Limestone Member consists mainly of massive micrite, biomicrite, horizontally-burrowed micrite, micrite with dolomitic stringers andrare _Tetradium_ boundstone, intraspararenite, siltstone, birdseye micrite, algallaminated micrite and oncolitic calcarenite. The section measured along Settlement Road, with its associated brachiopod ranges is presented graphically in fig. 2.10 a & b.

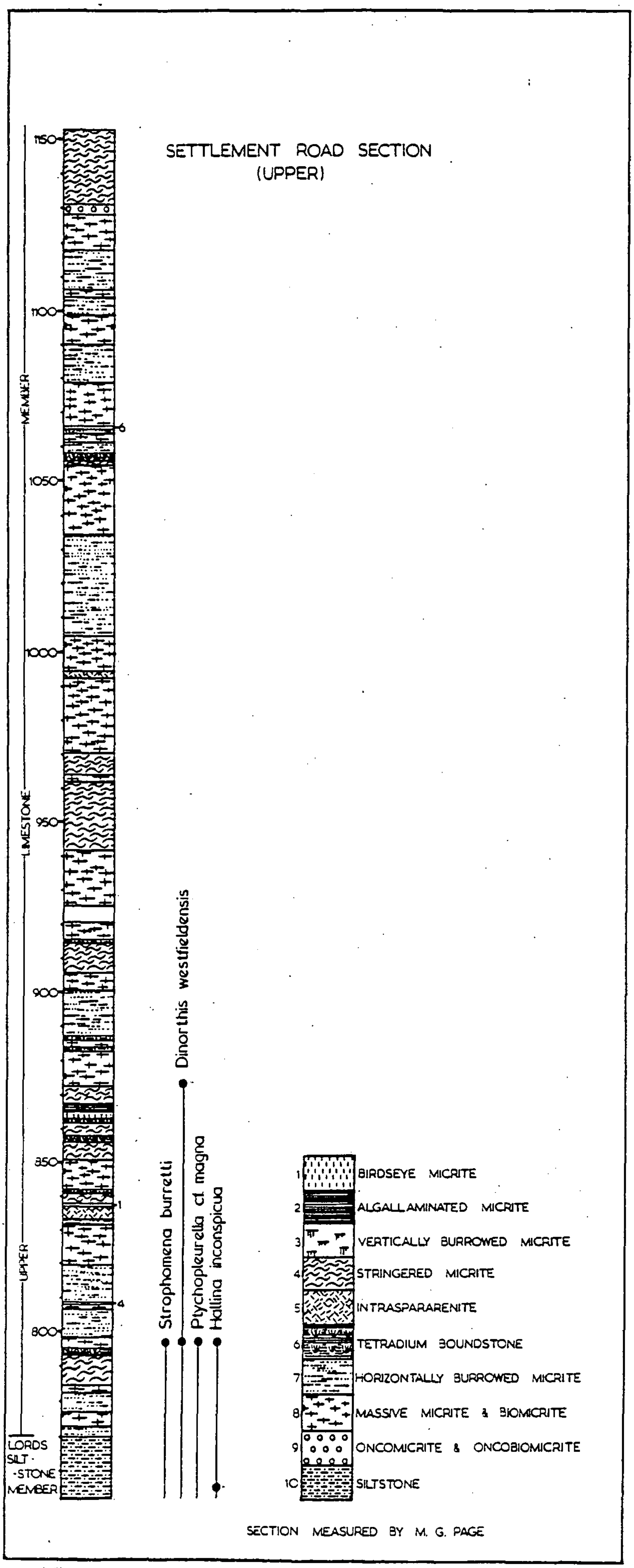
In the section along Eleven Road, only an incomplete section of the Lower Limestone Member is found. Here the member consists mainly of horizontally-burrowed micrite, micrite with dolomitic stringers, with less common algal-laminated micrite, intraspararenite, _Tetradium_ boundstone, massive micrite and biomicrite, birdseye micrite with rare vertically-burrowed micrite and oncolitic calcarenite.

Figure 2.10a. Lower portion of Settlement Road section with associated brachiopod ranges. This diagram includes the Cashions Creek Limestone and the Lower Limestone Member of the Benjamin Limestone.



SETTLEMENT ROAD SECTION (LOWER)
CASHIONS CREEK LIMESTONE LOWER MEMBER
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750
Lepidomena fortimuscula
Rhynchotrema bailliei
Apatomorpha melrosensis
?Strophomena sp.
Bellimurina cf. compressa
Hesperorthis longirostroides
Dactylogonia rara
Chaganella sp.
Maydenella asymmetrica
Teratelasmella plicata
aff Megamyonia sp.
Lepidomena pulchra
Oepikina banksi
?Rhynchotrema sp.
?Azamella sp.
Tasmanorthis calveri
Azamella rotunda
Azamella sulcata
Tasmanorthis costata
?Rhynchotrema sp.
Strophomena cf. oklahomensis
atrypide gen. et sp indet.
Holtedahlina sp.
Strophomena burretti
Dinorthis westfieldensis
Hesperorthis benjaminensis
Ptychopleurella cf. magna
Rhynchotrema ?iowense
Hallina inconspicua
Protozyga aseptata
Sowerbyites vesciseptus
1 BIRDSEYE MICRITE
2 ALGALLAMINATED MICRITE
3 VERTICALLY BURROWED MICRITE
4 STRINGERED MICRITE
5 INTRASPARARENITE & INTRABIOSPARARENITE
6 TETRADIUM BOUNDSTONE
7 HORIZONTALLY BURROWED MICRITE
8 MASSIVE MICRITE & BIOMICRITE
9 ONCOMICRITE & ONCOBIOMICRITE
10 BIOSPARITE & PELSPARITE
SECTION MEASURED BY
C. CALVER & J. LAURIE

Figure 2.10b. Upper portion of Settlement Road section with associated brachiopod ranges. This diagram includes the Lords Siltstone Member and the Upper Limestone Member of the Benjamin Limestone.


SETTLEMENT ROAD SECTION
(UPPER)
1150
1100
1050
1000
950
900
850
800
UPPER LIMESTONE MEMBER
LORDS SILT-STONE MEMBER
Strophomena burretti
Ptychopleurella cf. magna
Hallina inconspicua
Dinorthis westfieldensis
1 BIRDSEYE MICRITE
2 ALGAL LAMINATED MICRITE
3 VERTICALLY BURROWED MICRITE
4 STRINGERED MICRITE
5 INTRASPARARENITE
6 TETRADIUM BOUNDSTONE
7 HORIZONTALLY BURROWED MICRITE
8 MASSIVE MICRITE & BIOMICRITE
9 ONCOMICRITE & ONCOBIOMICRITE
10 SILTSTONE
SECTION MEASURED BY M. G. PAGE

The section along Eleven Road, with its associated brachiopod ranges is presented graphically in fig. 2.14.

Westfield Sandstone (=Westfield Beds of Corbett and Banks 1974; = Arndell Sandstone of Baillie 1979)

This unit was erected by Corbett and Banks (1974, p.226) to include buff siltstone, fine sandstone and some coarse sandstone exposed along Westfield Road, in the core of the Westfield Syncline (see figs. 2.2 and 2.11). The sandstones outcropping in the large roadmetal quarry to the south of Westfield Road were at first (Corbett and Banks op. cit. p.226, paragraph 1) assigned to neither the Westfield Beds or the overlying Eldon Group correlates (= Tiger Range Group of Baillie 1979) with any certainty. Later (Corbett and Banks op. cit. p.226, paragraph 4) the sandstones in this quarry were assigned definitely to the Eldon Group correlates. Baillie (1979,p7) erected the Arndell Sandstone for buff siltstone and very fine-grained sandstone overlying the Benjamin Limestone on the eastern flank of Tiger Range and in the Westfield Quarry area. Thus the Arndell Sandstone is synonymous with the Westfield Beds and part of the "Eldon Group" as represented by Corbett and Banks 1974.

Baillie, in defence of the concept of the Arndell Sandstone stated that the sections used to characterise

Figure 2.11. Location of Westfield Road section through the Benjamin Limestone and the Westfield Sandstone.

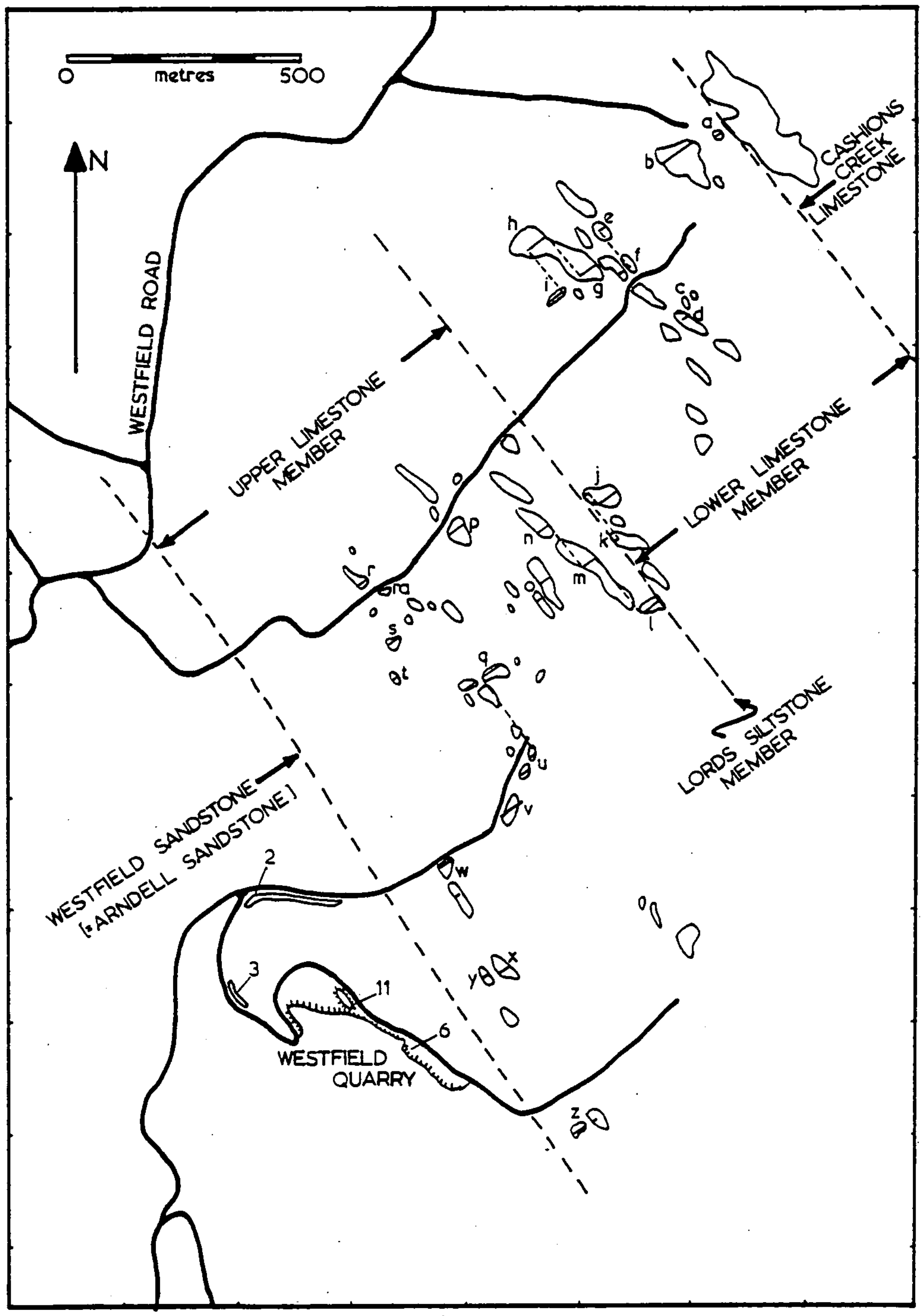
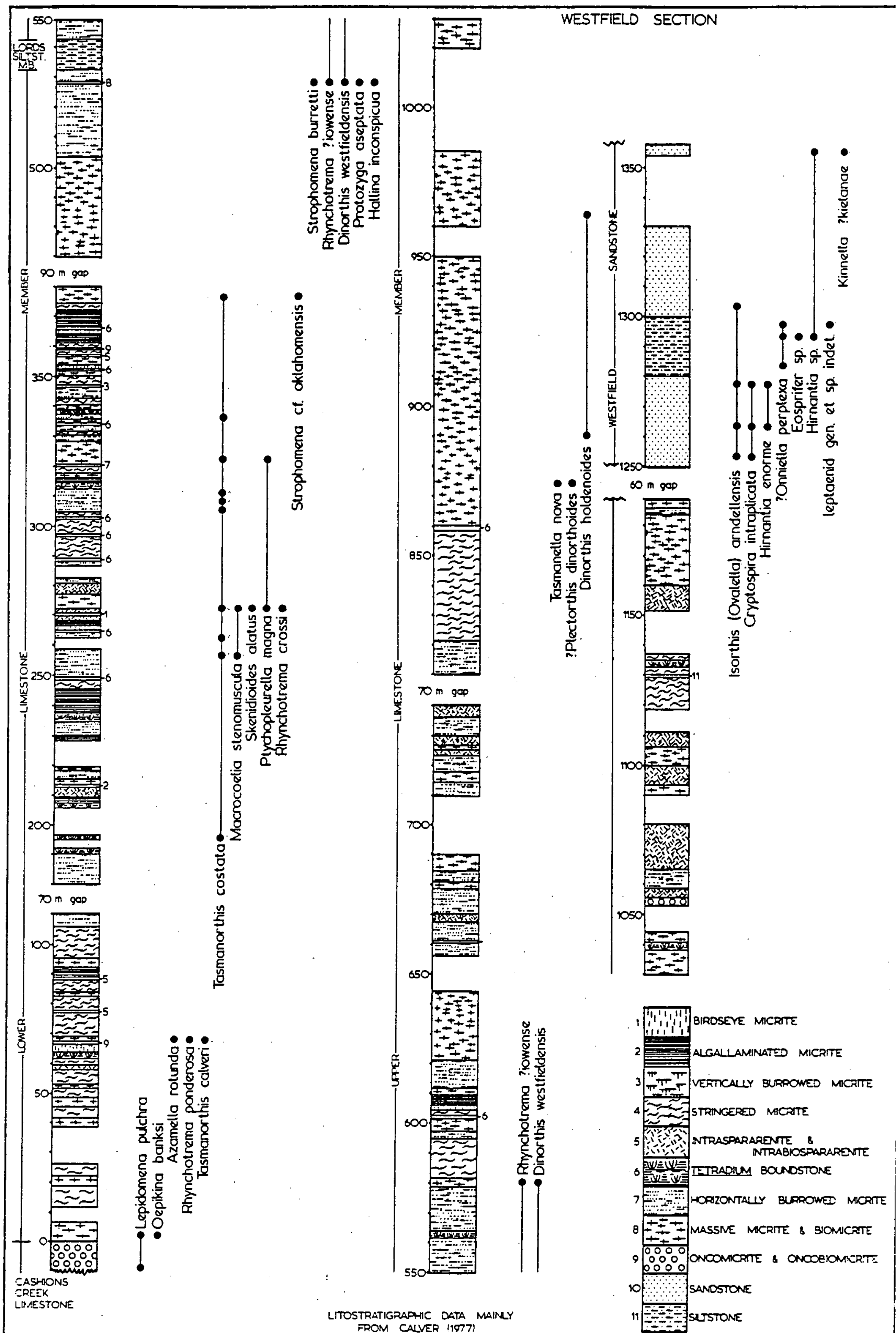

0 metres 500
N
WESTFIELD ROAD
UPPER LIMESTONE MEMBER
LOWER LIMESTONE MEMBER
CASHIONS CREEK LIMESTONE
LORDS SILTSTONE MEMBER
WESTFIELD SANDSTONE
[=ARNDELL SANDSTONE]
WESTFIELD QUARRY
2
3
11
6

Figure 2.12. Westfield Road section through Benjamin Limestone and Westfield Sandstone with associated brachiopod ranges.



WESTFIELD SECTION
LORDS SILTST. MB.
CASHIONS CREEK LIMESTONE
LOWER LIMESTONE MEMBER
UPPER LIMESTONE MEMBER
WESTFIELD SANDSTONE
70 m gap
90 m gap
60 m gap
Lepidomena pulchra
Oepikina banksi
Azamella rotunda
Rhynchotrema ponderosa
Tasmanorthis calveri
Tasmanorthis costata
Macrocoelia stenomusculata
Skenidioides alatus
Ptychopleurella magna
Rhynchotrema crossi
Strophomena cf. oklahomensis
Strophomena burretti
Rhynchotrema ?iowense
Dinorthis westfieldensis
Protozyga aseptata
Hallina inconspicua
Tasmanella nova
?Plectorthis dinorthoides
Dinorthis holdenoides
Isorthis (Ovalella) arndellensis
Cryptospira intraplicata
Hirnantia enorme
?Onniella perplexa
Eospirifer sp.
Hirnantia sp.
leptaenid gen. et sp. indet.
Kinnella ?kielanae
1 BIRDSEYE MICRITE
2 ALGALLAMINATED MICRITE
3 VERTICALLY BURROWED MICRITE
4 STRINGERED MICRITE
5 INTRASPARARENITE & INTRABIOSPARARENITE
6 TETRADIUM BOUNDSTONE
7 HORIZONTALLY BURROWED MICRITE
8 MASSIVE MICRITE & BIOMICRITE
9 ONCOMICRITE & ONCOBIOMICRITE
10 SANDSTONE
11 SILTSTONE
LITOSTRATIGRAPHIC DATA MAINLY FROM CALVER (1977)

the Westfield Beds were "poorly exposed and unsatisfactory" (Baillie, _op_. _cit_. p.5) and that the lithologies used to characterise this latter unit are "repetitive and a comparatively minor element in a thick and essentially sandstone sequence". He also noted, as Corbett and Banks themselves admitted (p.226) that the base of the unit had not been seen and that its upper contact with the "Eldon Group" was not clearly defined.

The author is in agreement with Baillie in believing the Westfield Beds to be poorly defined. Corbett and Banks (_op_. _cit_.) should perhaps more reasonably have placed the unit under informal nomenclature rather than formalising a name on such meagre data. Baillie, on the other hand, should perhaps have retained the name Westfield Beds or the more definitive Westfield Sandstone whilst redefining the unit on the basis of his nominated type sections as Corbett and Banks nominated no type section. This is the scheme adopted by Webby _et al_. (1981).

Only one partial section of the Westfield Sandstone was measured, that through the large roadmetal quarry south of Westfield Road (see fig. 2.11). Here the unit consists of buff, yellow or orange fine- to medium-grained quartz sandstone with lesser buff siltstone. The section through the quarry is contiguous with the Westfield section of the Benjamin Limestone consequently the section and its brachiopod ranges are presented on the same diagram, fig. 2.12.

Figure 2.13. Location of Eleven Road section through Lower Limestone Member of Benjamin Limestone.

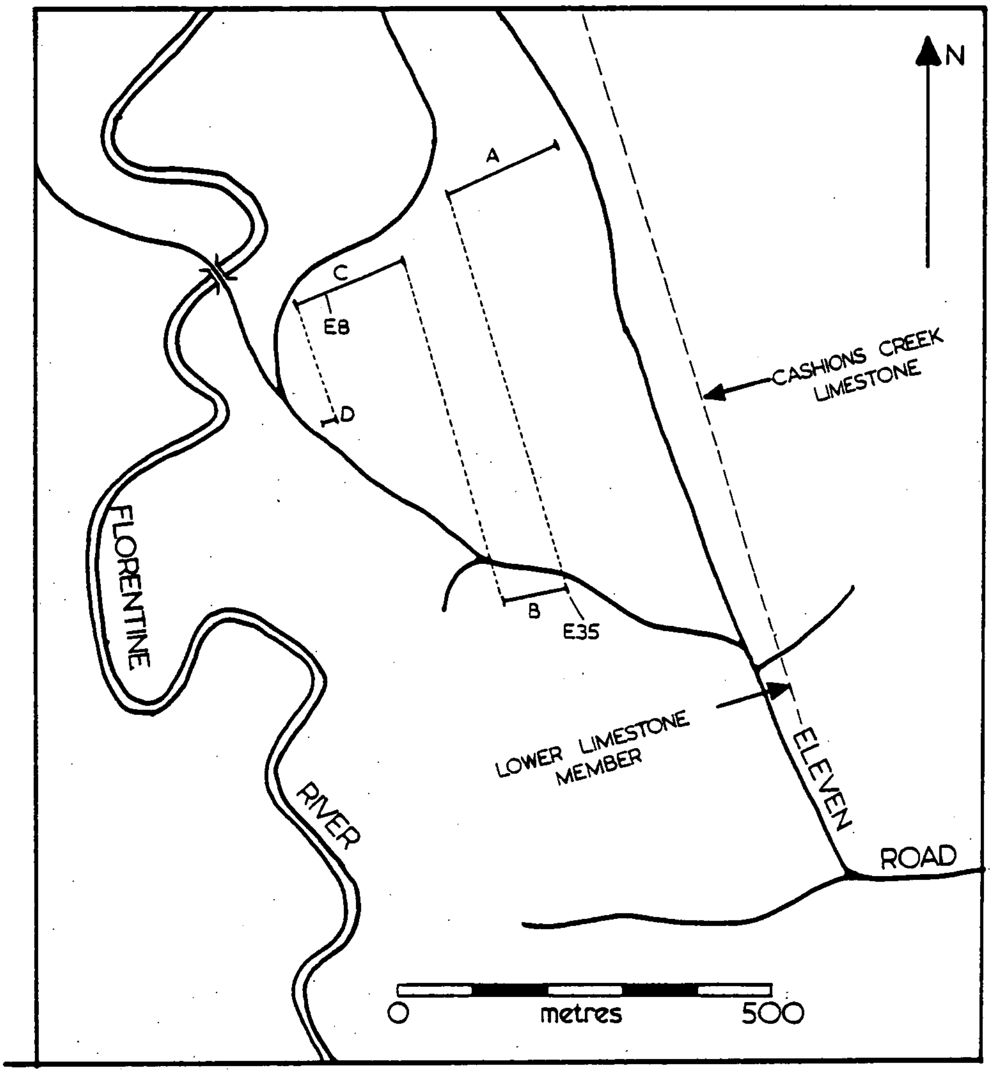
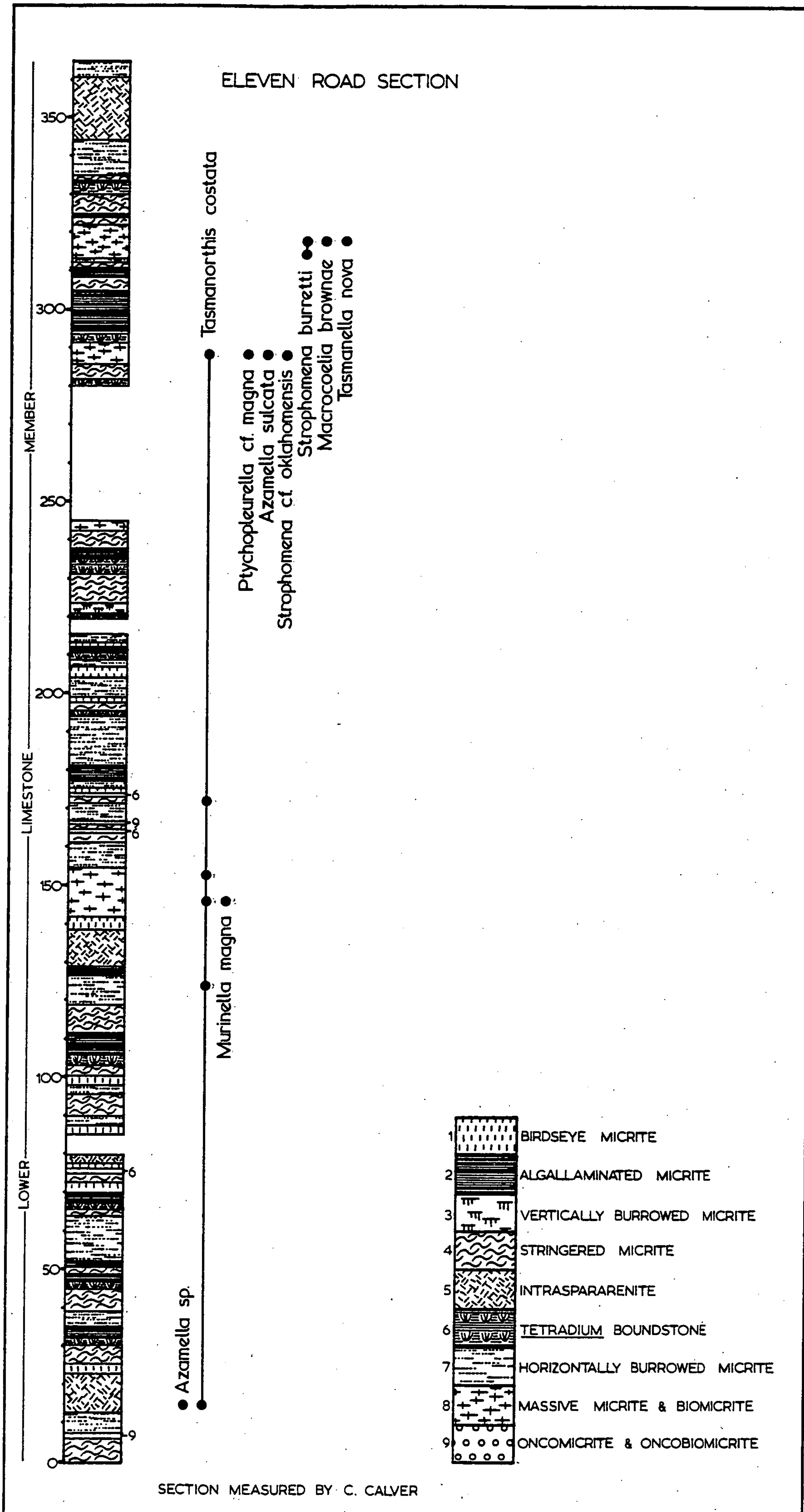
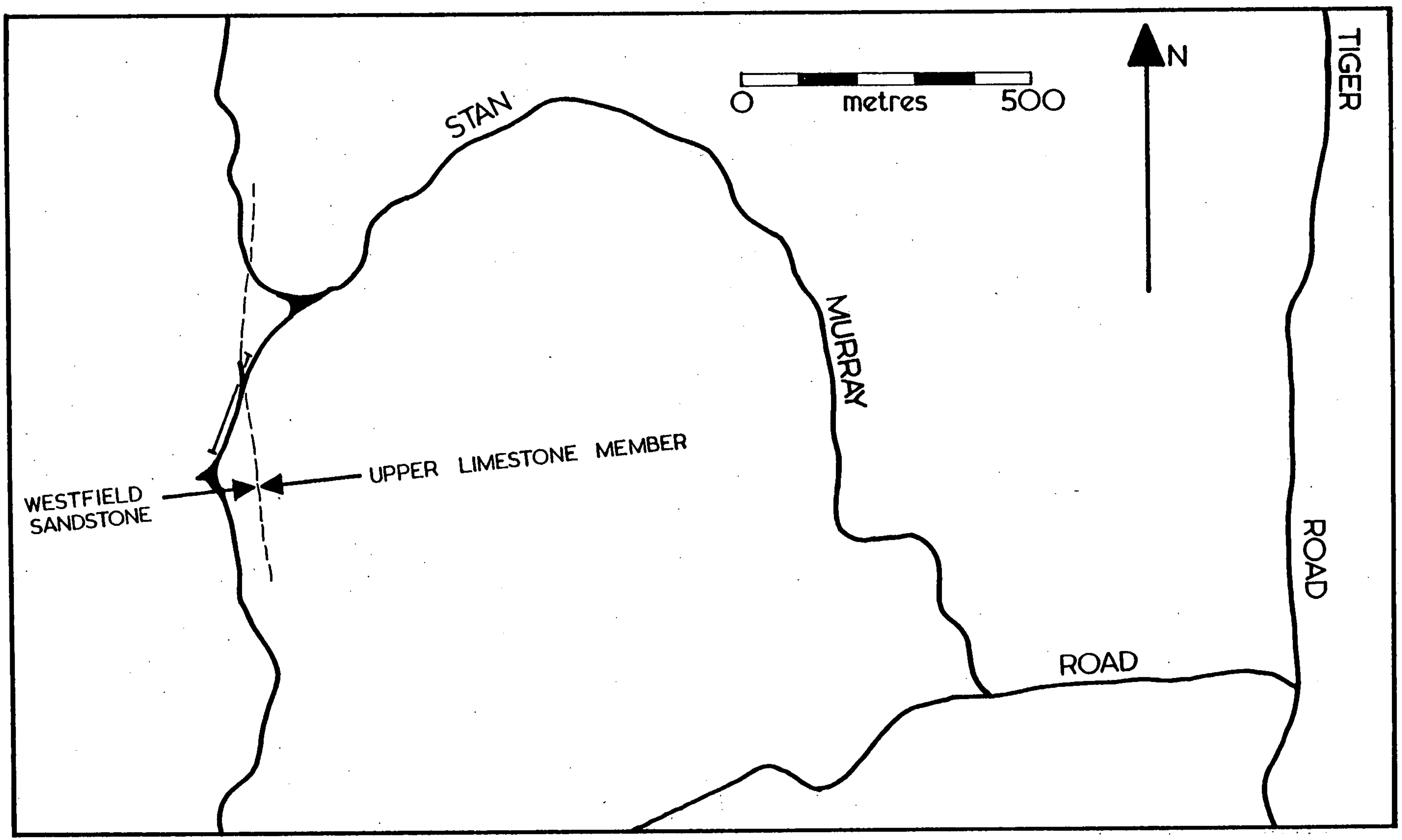

N
A
C
E8
D
B
E35
CASHIONS CREEK
LIMESTONE
FLORENTINE
RIVER
LOWER LIMESTONE
MEMBER
ELEVEN
ROAD
0
metres
500

Figure 2.14. Eleven Road section through Lower Limestone Member of Benjamin Limestone with associated brachiopod ranges.


ELEVEN ROAD SECTION
LOWER LIMESTONE MEMBER
350
300
250
200
150
100
50
0
Tasmanorthis costata
Ptychopleurella cf. magna
Azamella sulcata
Strophomena cf. oklahomensis
Strophomena burretti
Macrocoelia brownae
Tasmanella nova
Murinella magna
Azamella sp.
1 BIRDSEYE MICRITE
2 ALGALLAMINATED MICRITE
3 VERTICALLY BURROWED MICRITE
4 STRINGERED MICRITE
5 INTRASPARARENITE
6 TETRADIUM BOUNDSTONE
7 HORIZONTALLY BURROWED MICRITE
8 MASSIVE MICRITE & BIOMICRITE
9 ONCOMICRITE & ONCOBIOMICRITE
SECTION MEASURED BY C. CALVER

The type section of the Westfield Sandstone (along Stan Murray Road and Range Road) was not particularly fossiliferous and therefore this section was not collected in detail. However, some small, though largely fragmented faunas were collected. In the topmost outcrop of the Benjamin Limestone, specimens of Dinorthis holdenoides sp. nov. were obtained. In the lower portions of the Westfield Sandstone (perhaps 30 metres above the base) faunas containing Isorthis (Ovalella) arndellensis sp. nov. occur. The location of the boundary between the Benjamin Limestone and the Westfield Sandstone along Stan Murray Road is shown in fig. 2.15.

Figure 2.15. Location of Benjamin Limestone - Westfield Sandstone boundary along Stan Murray Road, in the Tiger Range area.



STAN
0
metres
500
N
TIGER
MURRAY
UPPER LIMESTONE MEMBER
WESTFIELD
SANDSTONE
ROAD
ROAD

CHAPTER THREE

RAILTON & EUGENANA AREAS

RAILTON AREA

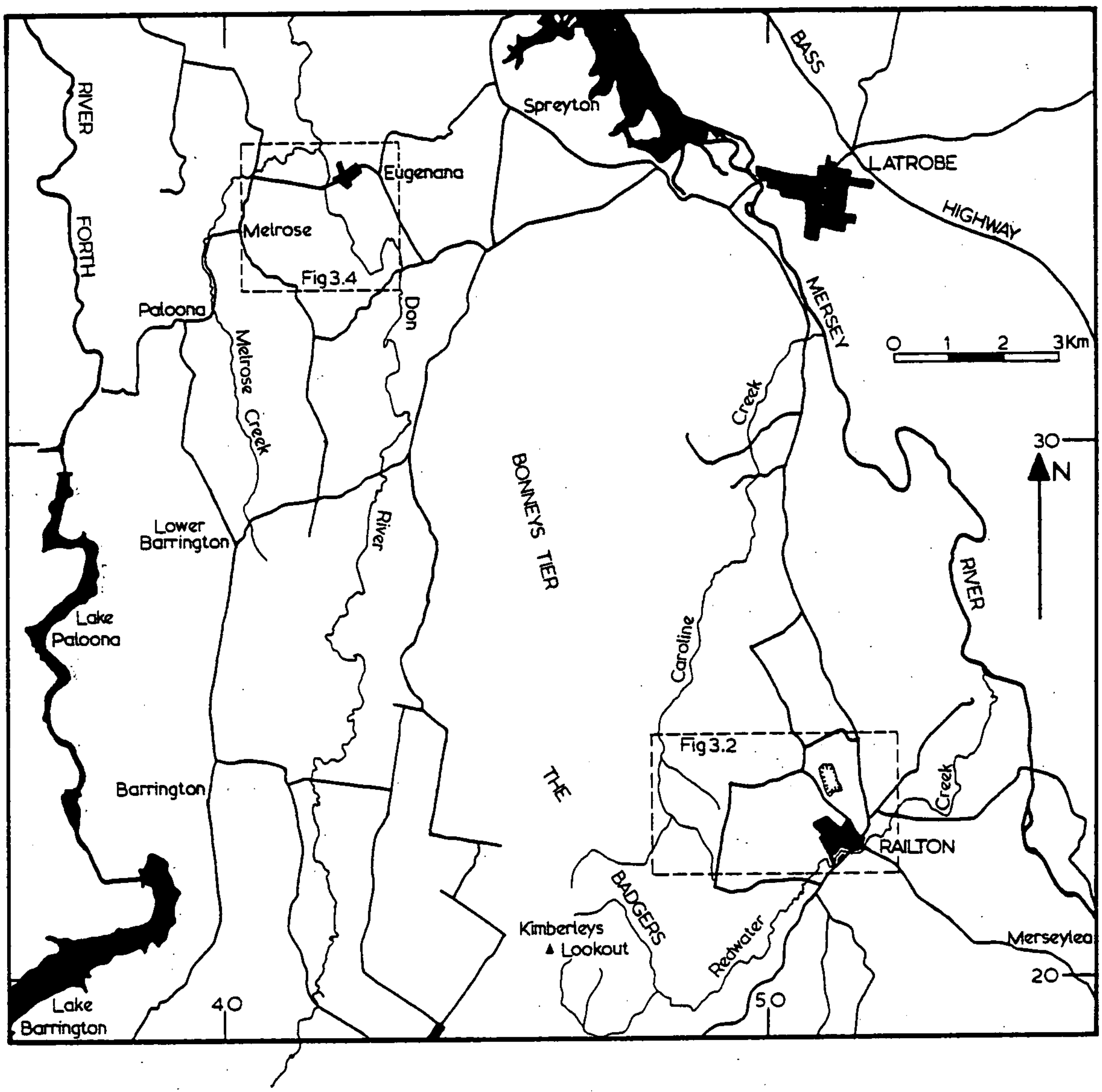
INTRODUCTION

Railton is a small town in northern Tasmania (see fig 1.1) the economy of which is centred on timber-getting and cement manufacture. The town is to the south of Latrobe and Devonport and about 3 km west of the Mersey River (see fig 3.1). It lies in the core of a broad NW trending syncline in an Early to Middle Ordovician siliciclastic - carbonate sequence. In the centre of the syncline outcrop limestones which have been quarried (Goliath Cement Works Quarry and Blenkhorns Quarry) for use in cement production. On the southern flank of the syncline some of the siliciclastics are being quarried (Caroline Quarry) for use as roadmetal.

PREVIOUS WORK

Little detailed geological work has been undertaken in the Railton area. Until the mid-1950s the only form of geological investigations into the area had been of a reconnaissance nature (Strzelecki 1845, Gould 1865, Johnston 1888), associated with evaluation of mineral

Figure 3.1. Location of Railton and Eugenana areas, northern Tasmania.



RIVER
FORTH
Paloona
Melrose
Eugenana
Fig 3.4
Melrose Creek
Don
River
Spreyton
BASS
LATROBE
HIGHWAY
MERSEY
0 1 2 3Km
30
N
Creek
BONNEYS TIER
Lower Barrington
Lake Paloona
Caroline
RIVER
Fig 3.2
THE
Barrington
RAILTON
Creek
BADGERS
Kimberleys Lookout
Redwater
Merseylea
20
Lake Barrington
40
50

potential (eg. Reid 1924) or palaeontological (Etheridge 1883, Kobayashi, 1940b).

Mapping on a regional scale began during the 1950s (Jennings, in Hughes 1957; Banks, in Hughes 1957; Jennings et. al. 1959).

More recently Scanlon (1976 unpubl hon thesis) and Burrett (1978 unpubl Ph. D. thesis) have undertaken stratigraphic and palaeontological studies in the area, Scanlon concentrating on the Lower Ordovician clastics and Burrett on the Middle Ordovician limestones in Goliath Cement Works Quarry.

LITHOSTRATIGRAPHY

Roland Conglomerate

This name was erected by Jennings (1958) to include pebble to boulder conglomerates separated by an angular unconformity from the underlying Cambrian sediments and overlain conformably by the Lower Ordovician siltstones and sandstones of the Caroline Creek Sandstone. The Roland Conglomerate forms the topographic high known as The Badgers about 4 km to the west of Railton township (see fig 3.1). The unit is being quarried in the southwestern portion of Caroline Quarry. The other two sections of the quarry lie entirely within fossiliferous units of the Caroline Creek Sandstone. As the Roland

Conglomerate is unfossiliferous it will be discussed no further.

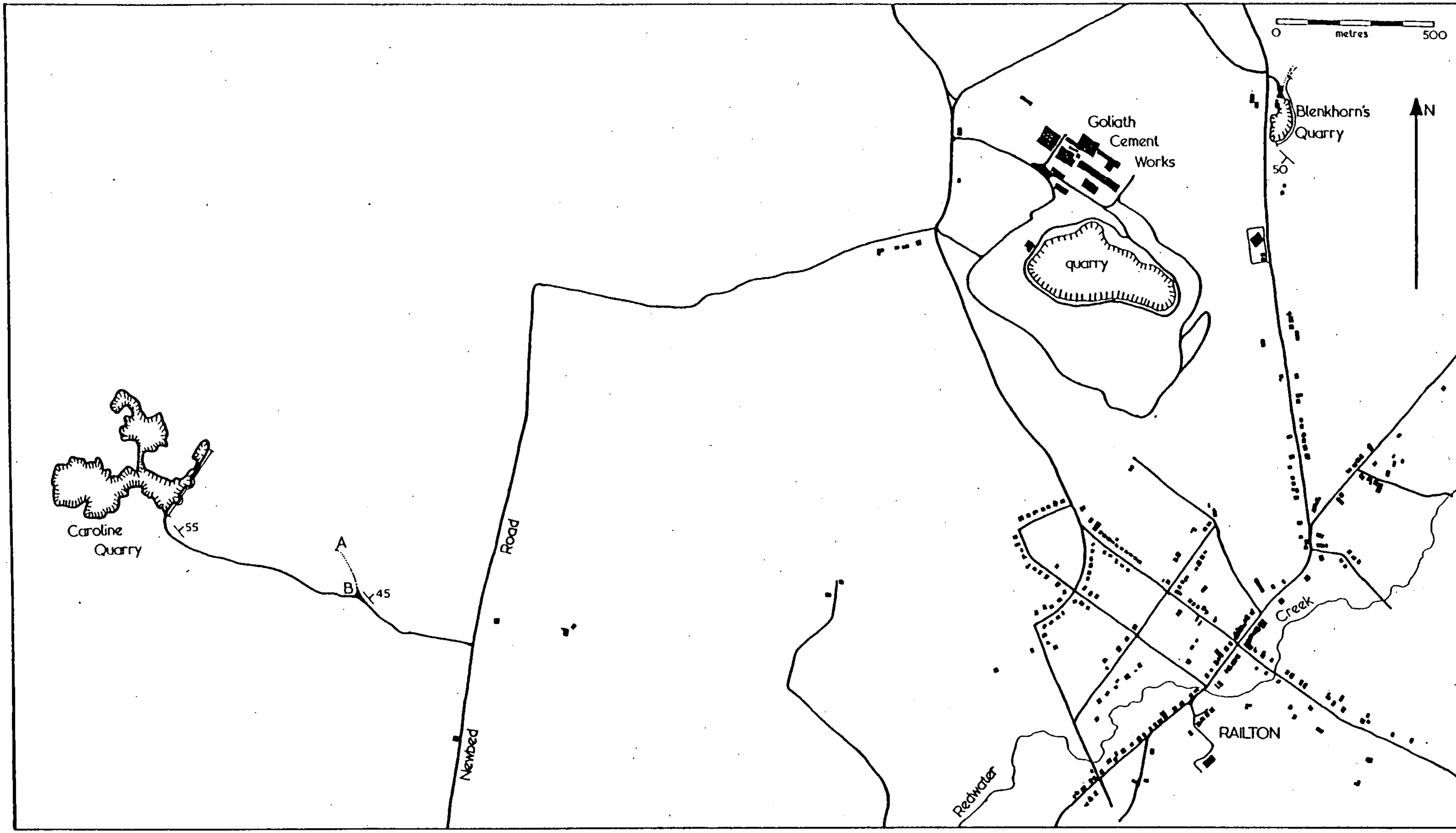
Caroline Creek Sandstone

The name Caroline Creek beds was first used by Etheridge (1883) in his description of fossils from a medium to coarse grained ferruginous sandstone outcropping along the railway line just south of Haines Siding, about 6.5 kilometres north of Railton. This term was expanded by Carey and Banks (1954, p.267) to include the siltstones and sandstones between the Lower Ordovician conglomerates and the "Gordon Limestone".

The term Caroline Creek Sandstone is used herein <u>sensu</u> Carey and Banks (op. cit.). Although the unit contains several distinct lithologies the poor outcrop in the Railton area precludes their use as formal mappable units. The relationships between the various rock types are largely unknown but there appear to be three main lithosomes (see Wheeler & Mallory 1956 for definition). These are:-

Lithosome A. This consists predominantly of massive brown, redbrown or orange, rarely purple siltstone with less common pale green to bluegreen fine friable sandstone. A well developed cleavage obscures the weakly developed sedimentary layering. This unit outcrops in cuttings along the Caroline Quarry Road, in a small costean to the north of this road (Locality A,

Figure 3.2. Location of sections and collection sites in the Railton area. Sections are located at Blenkhorn's Quarry and near Caroline Quarry and intersect portions of the Caroline Creek Sandstone.



Caroline
Quarry
55
A
B
45
Newbed
Road
Goliath
Cement
Works
quarry
Blenkhorn's
Quarry
50
0
metres
500
N
Redwater
Creek
RAILTON

fig 3.2) and in the northern and southeastern portions of Caroline Quarry itself. A section has been measured at this latter locality and is presented graphically, along with the ranges of associated brachiopod species in fig 3.3. On the other (northeastern) limb of the syncline it is probable that this unit is obscured by overlying Permian sediments.

The relationship between Lithosome A and the underlying Roland Conglomerate is unknown.

Lithosome B. This unit includes the outcrop from which the fossil collections described by Etheridge (1883) and Kobayashi (1904b) were made. The unit consists largely of medium - to coarse - grained silica cemented quartz sandstones and medium - grained micaceous lithic-quartz sandstone, in places containing vertical worm tubes. In addition to the above locality this unit outcrops (with overlying Permian sediments) in cuttings along the Latrobe Road, 3.5 to 4.5 km north of Railton (see fig 3.1) and in cuttings along the Sheffield Road 3 km to the south-southwest of Railton (see fig 3.1). No identifiable brachiopods were found in this unit and no sections were measured because of the nature of the outcrop. This unit is the medial, and probably the thickest unit of the Caroline Creek Sandstone. Its contacts with other units in the formation are unknown.

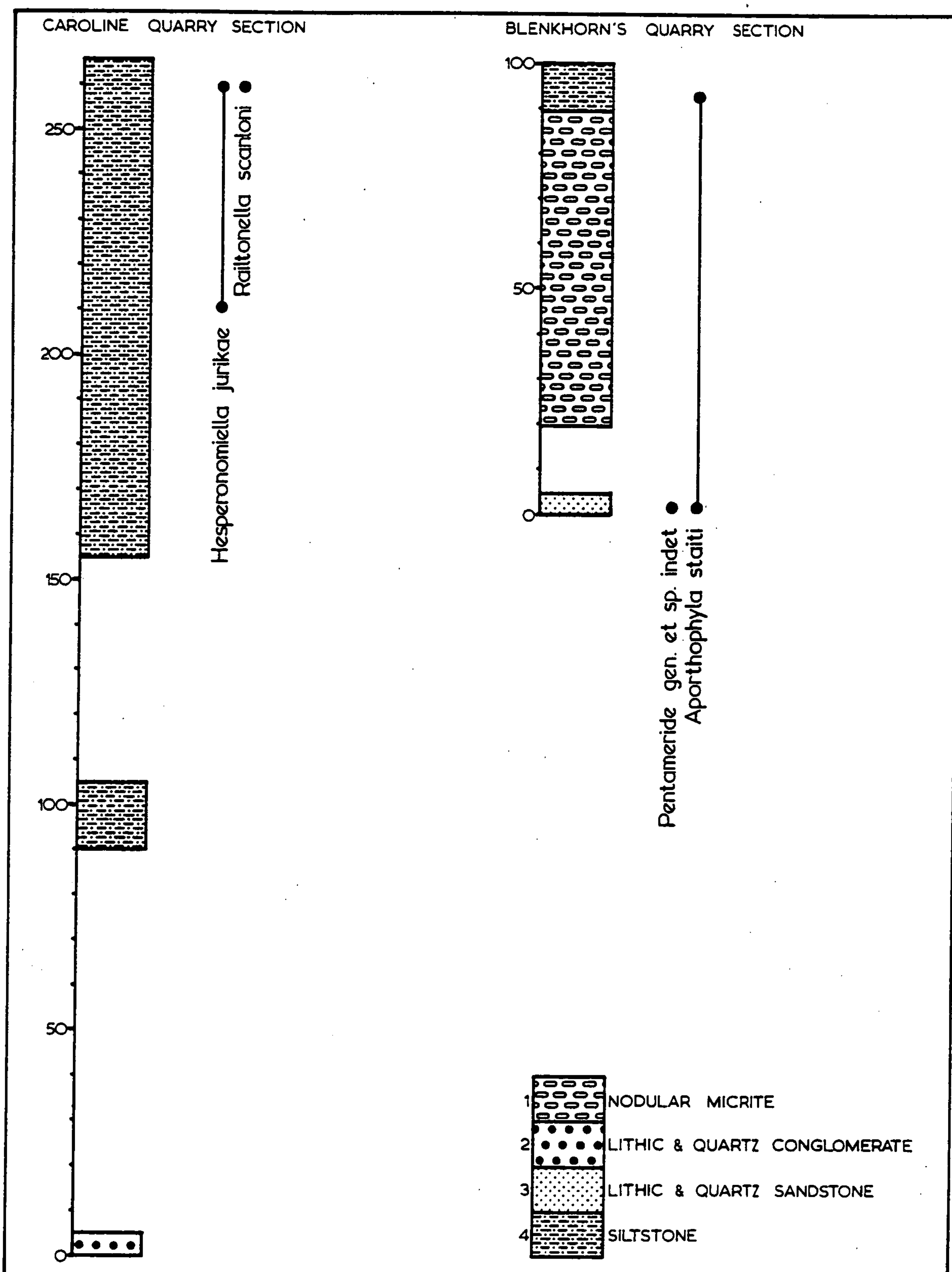
Lithosome C. This unit outcrops poorly and consists of a light brown, medium-grained, quartz-lithic clay cemented sandstone which is commonly friable. Only one area of outcrop of this unit is known and that is immediately to the north and northeast of Blenkhorn's Quarry (see fig 3.2). A section through part of this unit contiguous with that through Blenkhorn's Quarry has been measured and is presented graphically, with associated brachiopod ranges in fig 3.3. The relationship of this unit with the other units of the Caroline Creek Sandstone is unknown.

Gordon Subgroup

This subgroup is represented in the Railton area by the limestone and siltstone in Blenkhorn's Quarry (see fig 3.2) and by the limestone in Goliath Cement Works Quarry (see fig 3.2). The sequence in Blenkhorn's Quarry is structurally simple and consists of a nodular micrite overlain by a pale brown, occasionally yellow to reddish sometimes nodular siltstone with a well developed cleavage. A section through the quarry (and part of the underlying Caroline Creek Sandstone) is presented, with associated brachiopod ranges in fig 3.3.

The limestone in the Goliath Cement Works Quarry contains fossil cephalopods, gastropods and sponges (Banks, 1962; Banks & Johnson, 1957) but no identifiable brachiopods have been found. Because of this and the fact that the rocks are "cross folded and cut by several

Figure 3.3. Caroline Quarry and Blenkhorn's Quarry sections through parts of the Caroline Creek Sandstone and Gordon Subgroup with associated brachiopod ranges.


CAROLINE QUARRY SECTION
BLENKHORN'S QUARRY SECTION
250
200
150
100
50
0
Hesperonomiella jurikae
Railtonella scantoni
100
50
0
Pentameride gen. et sp. indet
Aporthophyla staiti
1 NODULAR MICRITE
2 LITHIC & QUARTZ CONGLOMERATE
3 LITHIC & QUARTZ SANDSTONE
4 SILTSTONE

small faults" (Burrett 1978), a feature which in freshly quarried limestone precludes adequate stratigraphic differentiation, the limestone in the Goliath Quarry is not dealt with in detail.

EUGENANA AREA

INTRODUCTION

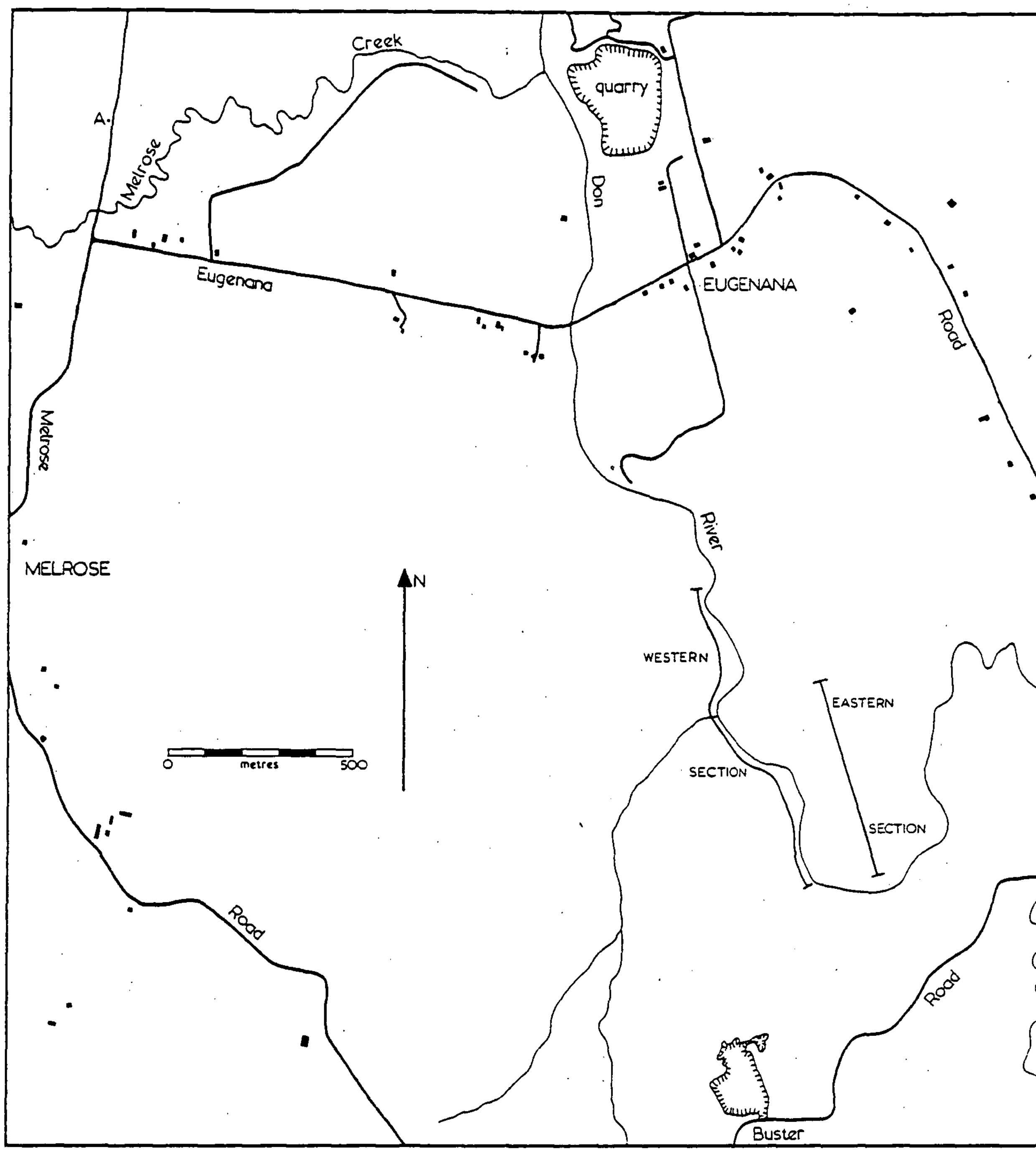
Eugenana is a small village in northern Tasmania (see fig 1.1) located southwest of Devonport, about 9 km west of Latrobe (see fig 3.1). The village is situated upon a folded sequence of Lower Ordovician siliciclastics and Middle Ordovician carbonates which is truncated by the Aberdeen Fault (Burns 1963) to the east.

The siliciclastics have occasionally been quarried on a small scale to obtain gravel whilst the carbonates have been quarried extensively at the Broken Hill Pty Ltd Quarry immediately north of Eugenana village (see fig 3.4). This quarry operates no longer and has now filled with water. It serves as a recreational lake.

PREVIOUS WORK

Prior to the 1960s the only work of a geological nature during this century had been investigations into the amount and quality of the limestone in the area

Figure 3.4. Location of sections and collection sites in the Eugenana area. Two sections are located in Denny Gorge (Don River), one on the eastern and one on the western side. Locality A, the type locality of *Apatomorpha melrosensis* is in northwest corner of the area.


Creek
quarry
A.
Melrose
Don
Eugenana
EUGENANA
Road
Melrose
River
MELROSE
N
WESTERN
EASTERN
SECTION
SECTION
0
metres
500
Road
Road
Buster

(Henderson 1937, Hughes 1957) or in evaluation of oil shale potential (Reid 1924).

Banks (in Spry & Banks 1962) briefly discussed the Lower Ordovician clastics (p 167) and noted the presence of probable Chazyan fossils in the carbonates at Eugenana (also noted by Banks & Johnson, 1957). Mapping on a regional scale of the Devonport 1:63360 sheet area was completed in the early 1960s (Burns 1964).

More recently, Scanlon (1976 unpubl hons thesis) has produced a detailed geological map of the Eugenana - Melrose area and measured numerous sections through portions of the Lower Ordovician clastics and several through the Middle Ordovician carbonates. Burrett (1978 unpubl Ph. D. thesis) collected and described conodonts from the Ordovician carbonates in the Melrose - Paloona area.

STRATIGRAPHY

Roland Conglomerate

This unit outcrops in the southern end of Denny Gorge (see fig 3.4). Here it consists of granule to cobble, lithic and quartzose, ferruginous conglomerate with lesser coarse sandstones of similar content. Two sections through portions of the unit (contiguous with sections of the Caroline Creek Sandstone) have been measured and are presented in fig 3.5. The unit is not fossiliferous and will be discussed no further.

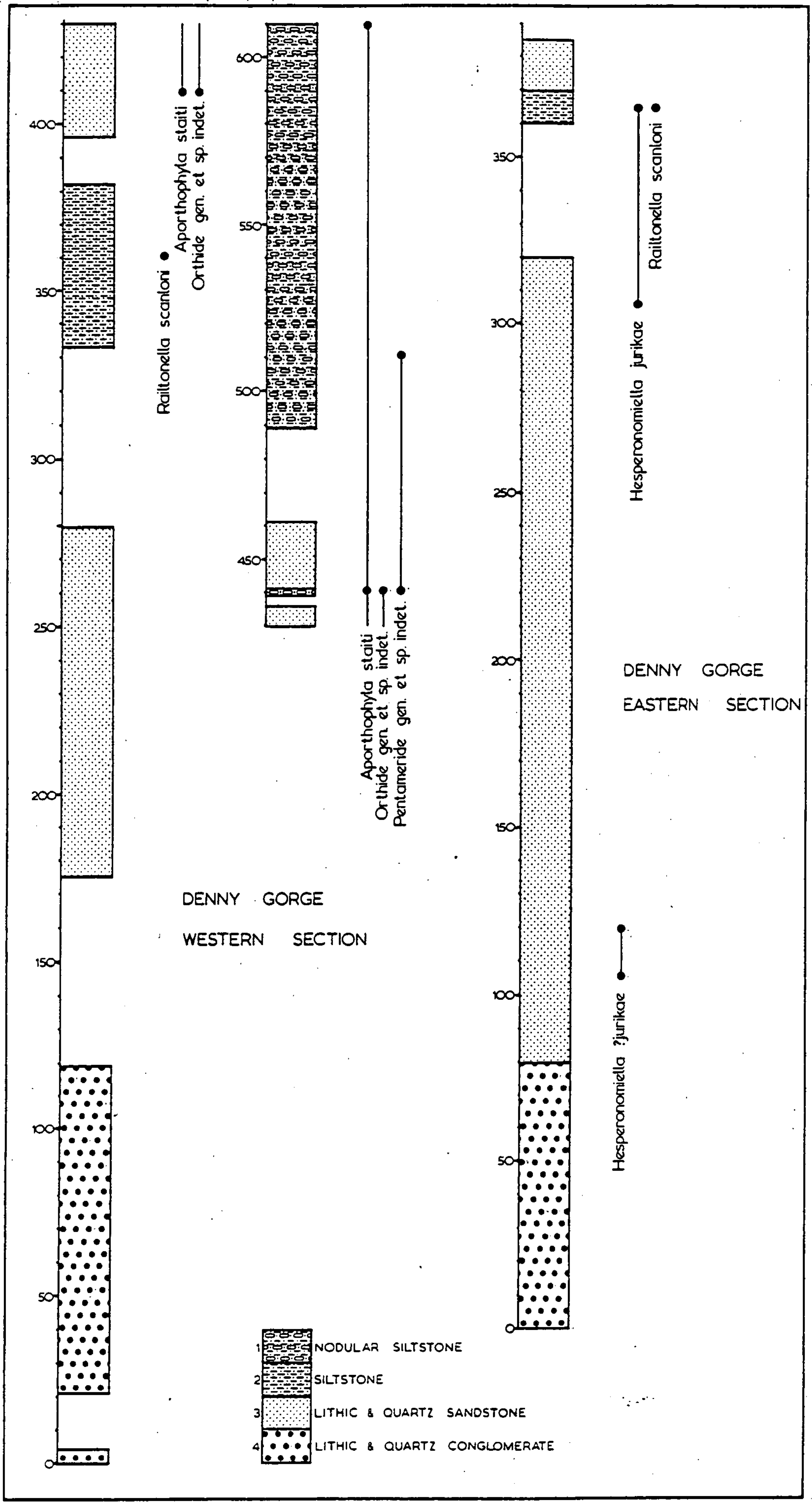
Caroline Creek Sandstone

As at Railton, generally poor outcrop, and a complete lack of outcrop of the upper portions of the formation precludes any finer subdivision of this rather thick, heterogeneous unit.

The best outcrops of the formation are in Denny Gorge. Here the unit conformably overlies the Roland Conglomerate and consists of a lower coarse to fine, quartz-lithic sandstone (generally finer toward the top) overlain by a yellowish, brownish, sometimes greenish-grey siltstone with a fairly well developed cleavage. This latter rock type is very similar in lithology and faunal content to the unit termed Lithosome A at Railton. This unit is in turn overlain by a coarse grained, very hard quartz-lithic ferruginous sandstone with occasional thin units of pale blue-green to yellowish brown nodular siltstone which usually possesses a well developed cleavage. The nodules, now weathered out, are assumed to have been calcareous, corresponding to similar features in portions of the Florentine Valley Formation and Karmberg Limestone (see Chapter 2).

The uppermost exposed unit of the Caroline Creek Sandstone in the Denny Gorge sequence is a yellowish

Figure 3.5. Eastern and Western Denny Gorge sections through parts of the Caroline Creek Sandstone and Roland Conglomerate with associated brachiopod ranges.


DENNY GORGE
WESTERN SECTION
Railtonella scanloni
Aporthophyla staiti
Orthide gen. et sp. indet.
Pentameride gen. et sp. indet.
DENNY GORGE
EASTERN SECTION
Hesperonomiella jurikae
Hesperonomiella ?jurikae
Railtonella scanloni
0
50
100
150
200
250
300
350
400
450
500
550
600
1 NODULAR SILTSTONE
2 SILTSTONE
3 LITHIC & QUARTZ SANDSTONE
4 LITHIC & QUARTZ CONGLOMERATE

brown to pale brown nodular siltstone similar to that occurring as a minor constituent of the generally coarser unit directly below. The two sections measured in Denny Gorge (one on the western and one on the eastern side) are presented, along with the ranges of associated brachiopods in fig 3.5.

Another isolated locality, presumably of Caroline Creek Sandstone (i.e. below the limestones) occurs in a farm track just to the west of a cutting in the Melrose Road about 250 metres north of the Melrose Creek bridge (locality A in fig 3.4). Here, _Apatomorpha melrosensis_ sp. nov. occurs in profusion. This species has not been found in the Denny Gorge sections but is found in the Cashions Creek limestone in the Florentine Valley (see Chapter 2).

Gordon Subgroup

Ordovician limestones have been quarried at Eugenana and outcrop about 0.7 km southeast of the Paloona turnoff at Melrose. The limestones in the quarries at Eugenana are poorly fossiliferous whilst those at the Melrose locality contain _Lepidomena fortimuscula_ gen. et sp. nov., a species quite common in the Cashions Creek Limestone in the Florentine Valley (see Chapter 2).

CHAPTER FOUR

MOLE CREEK AREA

INTRODUCTION

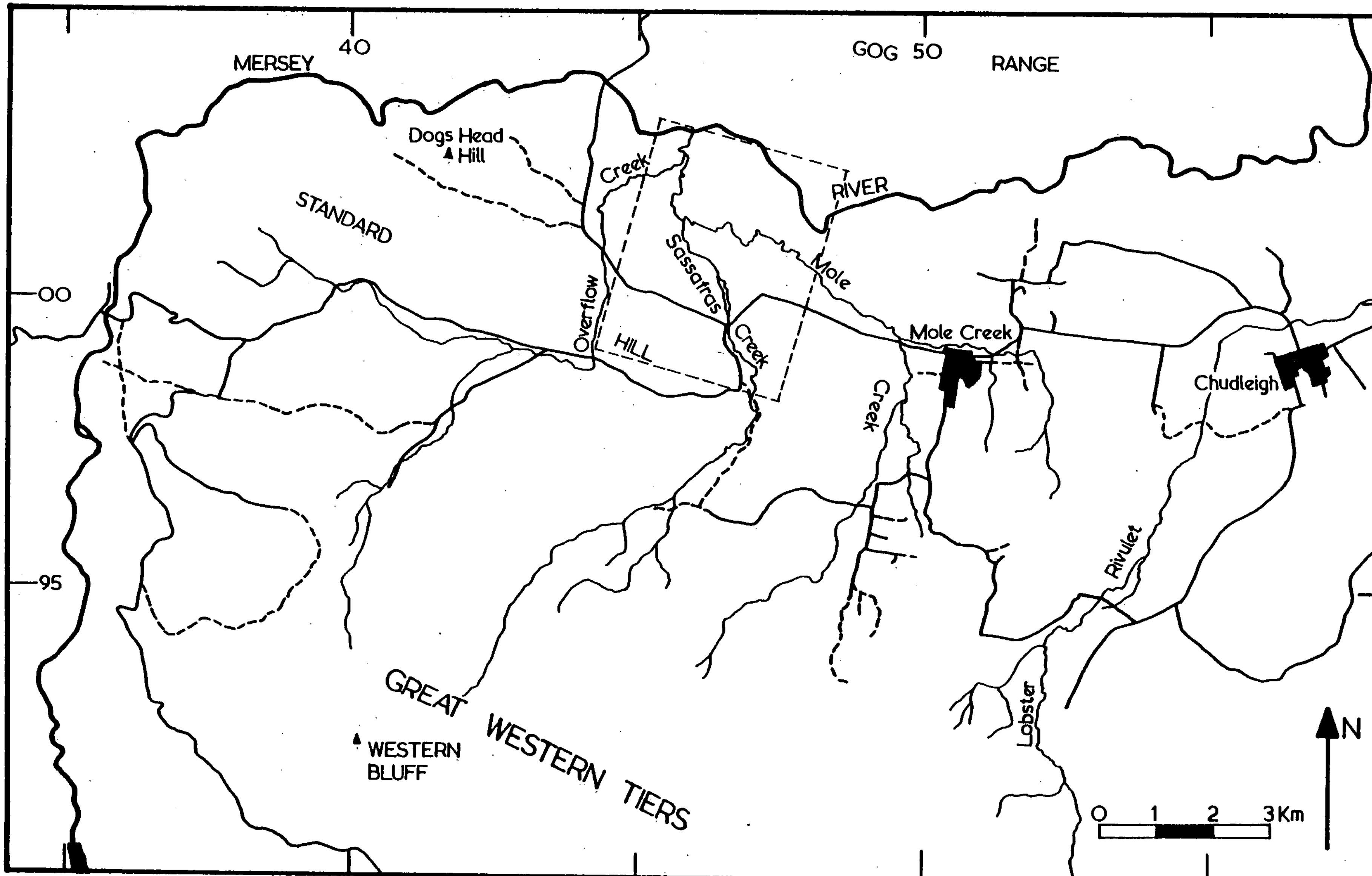
Mole Creek is a small town in northern Tasmania (see fig 1.1) about twenty kilometres south of Railton (see Chapter 3). It lies on the northern limb of a tight west-northwest trending anticline in a Early Ordovician to Early Silurian siliciclastic-carbonate sequence. In the core of the anticline Early to Middle Ordovician siliciclastics outcrop as the large strike ridge of Standard Hill (see fig 4.1). This is overlain by the Middle to Late Ordovician Chudleigh Limestone which is best exposed to the northeast of Standard Hill in the valley of the Mersey River.

PREVIOUS WORK

The limestone in the Mole Creek - Chudleigh area was first mentioned by Strzelecki (1845) and subsequently by Gould (1866) and Johnston (1888), who undertook studies of a reconnaissance nature in the area.

Prior to the 1950s little geological investigation had been undertaken in the area. It was during this decade that mapping on a regional scale was begun by the Department of Mines (Hughes, 1957; Jennings, 1963).

Figure 4.1. Locality map of Mole Creek - Chudleigh area. Area bordered by broken line is enlarged in fig. 4.3.


40
50
00
95
MERSEY
RIVER
GOG
RANGE
Dogs Head
Hill
STANDARD
HILL
Creek
Overflow
Sassafras
Creek
Mole
Mole Creek
Creek
Chudleigh
Rivulet
Lobster
GREAT WESTERN TIERS
WESTERN
BLUFF
N
0
1
2
3 Km

Banks (in Hughes op. cit.) gave a broad outline of the stratigraphy and briefly reviewed the palaeontology of the area. Banks later (in Spry and Banks, 1962) again reviewed the stratigraphy of the area but discussed the palaeontology in greater detail.

More recently Burrett (1978, unpubl. Ph. D. thesis) and Banks and Burrett (in prep.) have refined the stratigraphy of the limestones, delineating six members within the Chudleigh Limestone. Burrett (op. cit.) also studied the succession of conodont faunas in the Chudleigh Limestone.

LITHOSTRATIGRAPHY

Moina Sandstone

This formation was defined by Jennings (1963, p.56) as "that formation of marine sandstone, quartzite, shale and conglomerate about 800 ft thick, which occurs stratigraphically below the Gordon Limestone and above the Roland Conglomerate". This unit forms the topographic high that is Standard Hill. Few brachiopods have been found in the unit and preservation is poor therefore the unit is not dealt with in detail.

Gordon Subgroup

Chudleigh Limestone

This term was first used informally by Johnston (1888) whose concept of the unit was unknown. The term was rarely (if ever) used until Burrett (1978 unpubl. Ph. D. thesis) defined it as "the sequence of Ordovician limestones and minor siltstones, outcroppping between Standard Hill and the Mersey River 2.5 km west of Mole Creek" (p 30).

Burrett (op. cit.) estimated the Chudleigh Limestone to be 1300 metres thick. It consists of oncolitic, micritic and dolomitic limestone with minor calcarenites and siltstone.

Burrett (op. cit.) has subdivided the Chudleigh Limestone into "seven named members plus one informal lithological unit forty metres thick at the top" (p 30). The sequence of these members is presented in fig 4.2, with the unnamed unit at the top being included with the topmost named member. The members are briefly described below.

Standard Hill Member

This unit consits of 145 metres of oncolitic limestone with minor calcarenite immediately overlying the Moina Sandstone. It was recognised as a distinctive

Figure 4.2. Stratigraphy of Gordon Subgroup in the Mole Creek area. From Burrett (1978, unpubl. Ph.D. thesis).

<table>
<tr><td rowspan="8">GORDON
SUB-GROUP</td><td colspan="2">UNNAMED SILTSTONE</td></tr>
<tr><td rowspan="7">CHUDLEIGH
LIMESTONE</td><td>THE DEN MEMBER</td></tr>
<tr><td>OVERFLOW CREEK MEMBER</td></tr>
<tr><td>MOLE CREEK MEMBER</td></tr>
<tr><td>DOGS HEAD MEMBER</td></tr>
<tr><td>SASSAFRAS CREEK MEMBER</td></tr>
<tr><td>UGBROOK MEMBER</td></tr>
<tr><td>STANDARD HILL MEMBER</td></tr>
<tr><td>DENISON
SUB-GROUP</td><td colspan="2">MOINA SANDSTONE</td></tr>
</table>

lithological unit by Banks and Johnson (1957) who termed it the Maclurites-Girvanella bed. It is very similar in lithology to the Cashions Creek Limestone in the Florentine Valley (see chapter 2). The top of the Standard Hill Member is gradational into the overlying Ugbrook Member. The unit contains rare fragmentary brachiopods.

Ugbrook Member

This member consists of 120 metres of nodular limestones with minor micrites toward the top of the unit. The nodules in the unit consist of micrite surrounded by stringers of silty material up to 10 mm thick. The unit contains a moderately diverse, well-preserved brachiopod fauna.

Sassafras Creek Member

This unit is 135 metres thick and immediately overlies the Ugbrook Member. Its basal unit is a three metre thick bed of biospararenite with the remainder of the unit consisting largely of micrite and dolomitic micrite. The top of the member is taken at the top of a coquina containing occasional large oncolites (up to 20 mm diameter). The unit contains a few fragmentary brachiopods.

Dogs Head Member

This unit is a 470 metre thick sequence of micrites and dolomicrites with nodular chert common in its lower two thirds. The top of the member is drawn at the base of the lowest occurrence of reddish siltstone. The member outcrops fairly well and in places a moderately diverse brachiopod fauna is present.

Mole Creek Member

This member consists of reddish siltstone, micrite, calcarenite with minor black shale and is approximately 70 metres thick. The unit is lithologically similar to the Lords Siltstone Member of the Benjamin Limestone in the Florentine Valley (see chapter 2). Brachiopods are rare.

Overflow Creek Member

This unit is about 240 metres thick and consists mainly of unfossiliferous dolomicrites and dolosiltites. Some of the micrites contain gastropod fragments but brachiopods are unknown in the member therefore no sections have been measured through the unit.

Den Member

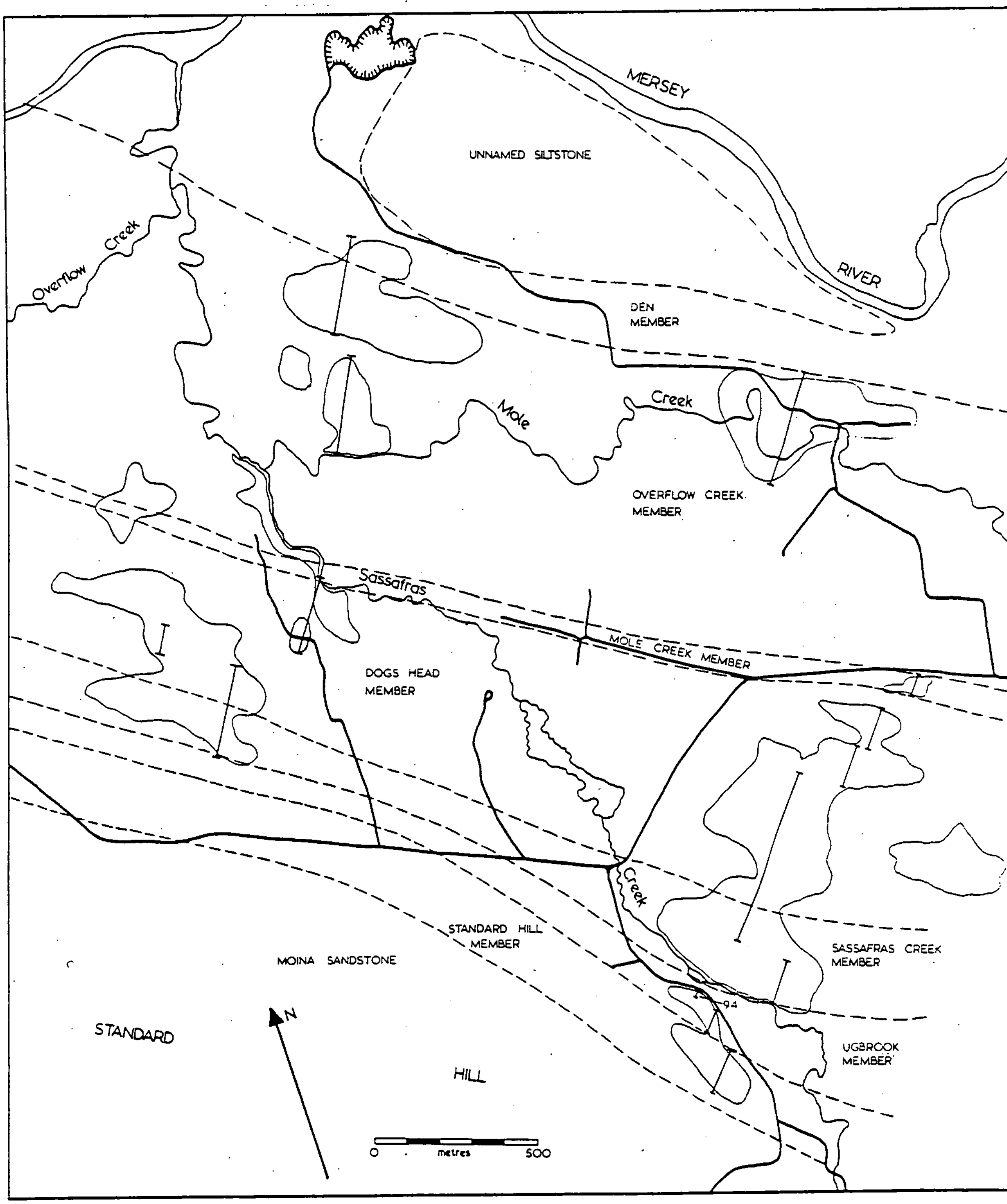
This is a 93 metre thick unit of coralline calcirudite and sparsely fossiliferous micrite that outcrops just to the east of the right-angle bend in the Mersey River. The fauna is very diverse with tabulate and rugose corals, stromatoporoids, bryozoans, bivalves and cephalopods. No brachiopods have been recorded from the unit hence no section has been measured. Above the Den Member (of Burrett 1978, unpublished Ph. D. Thesis) "is 40 metres of light coloured (grey-white) unfossiliferous micrites" (p 53). Burrett left this latter unit under open nomenclature. For the sake of convenience this unit is incorporated in the Den Member herein.

Measured Sections of the Chudleigh Limestone

Two sections of the lower five members of the Chudleigh Limestone are presented. One section (eastern section) has been measured northward from the eastern end of Standard Hill (see fig 4.3). This section and the ranges of its associated brachiopods are presented diagramatically in fig 4.4.

The other section (western section) has been measured in the area south of the junction of Mole Creek and Sassafras Creek. This section and the ranges of associated brachiopods are presented diagramatically in fig 4.5

Figure 4.3. Geological map of type area of Chudleigh Limestone with location of sections of lower five members, these being the only members containing fossil brachiopods.


MERSEY
RIVER
UNNAMED SILTSTONE
Overflow Creek
DEN MEMBER
Mole Creek
OVERFLOW CREEK MEMBER
Sassafras
MOLE CREEK MEMBER
DOGS HEAD MEMBER
Creek
STANDARD HILL MEMBER
MOINA SANDSTONE
SASSAFRAS CREEK MEMBER
94
UGBROOK MEMBER
N
STANDARD
HILL
0 metres 500

Unnamed Siltstone

This unit, the uppermost unit of the Gordon Subgroup in the area, outcrops in the eastern portion of the quarry near the Mersey River (see fig 4.5). It consists of light brown, fissile siltstone which contains an as yet undescribed brachiopod fauna (Isorthis sp and stropheodontid gen. et sp. indet.) of probable Early Silurian age.

Figure 4.4. Eastern section of the lower Chudleigh Limestone with ranges of associated brachiopods (lithostratigraphy adapted from Burrett, 1978, unpubl. Ph.D. thesis).

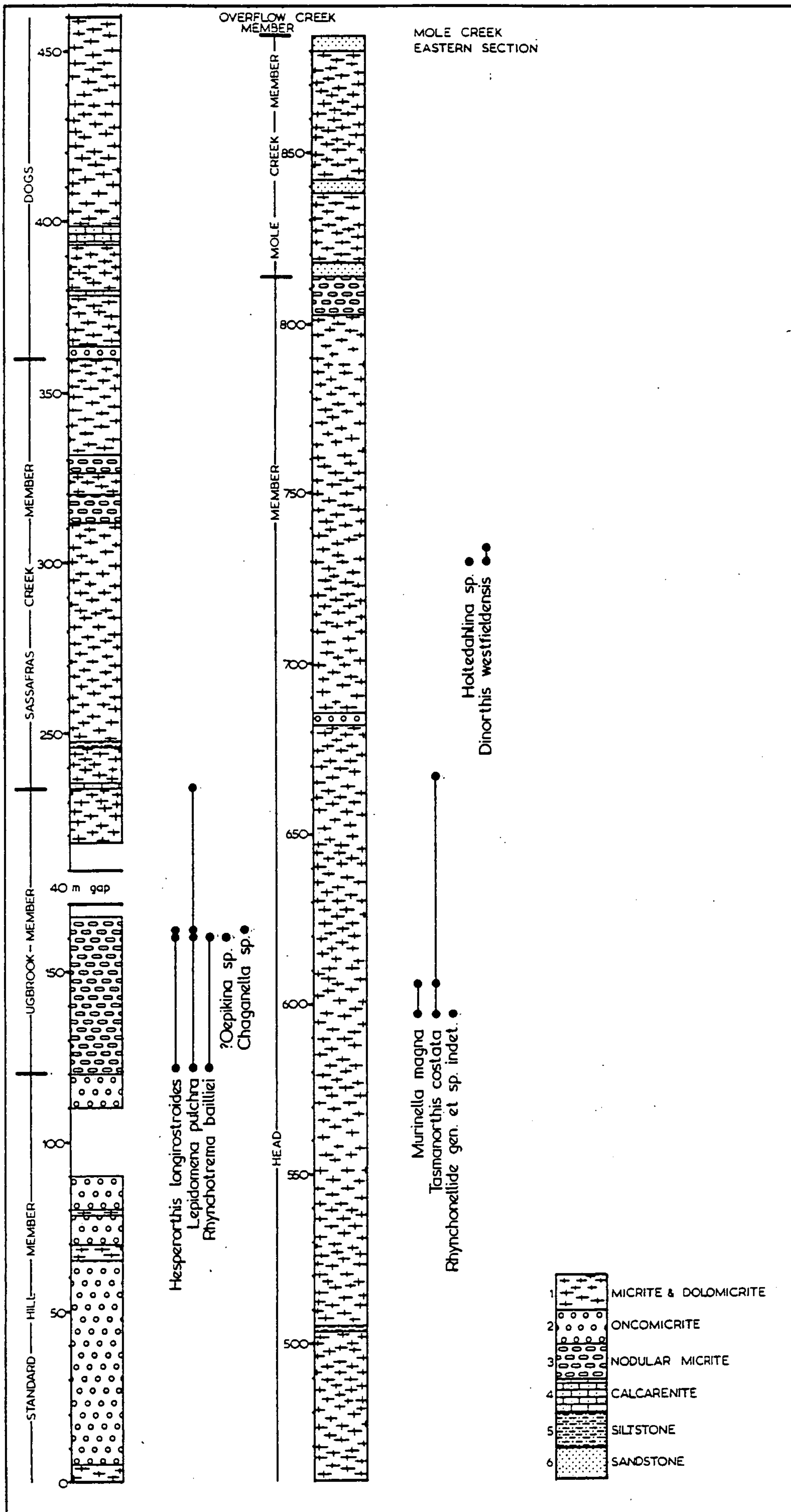
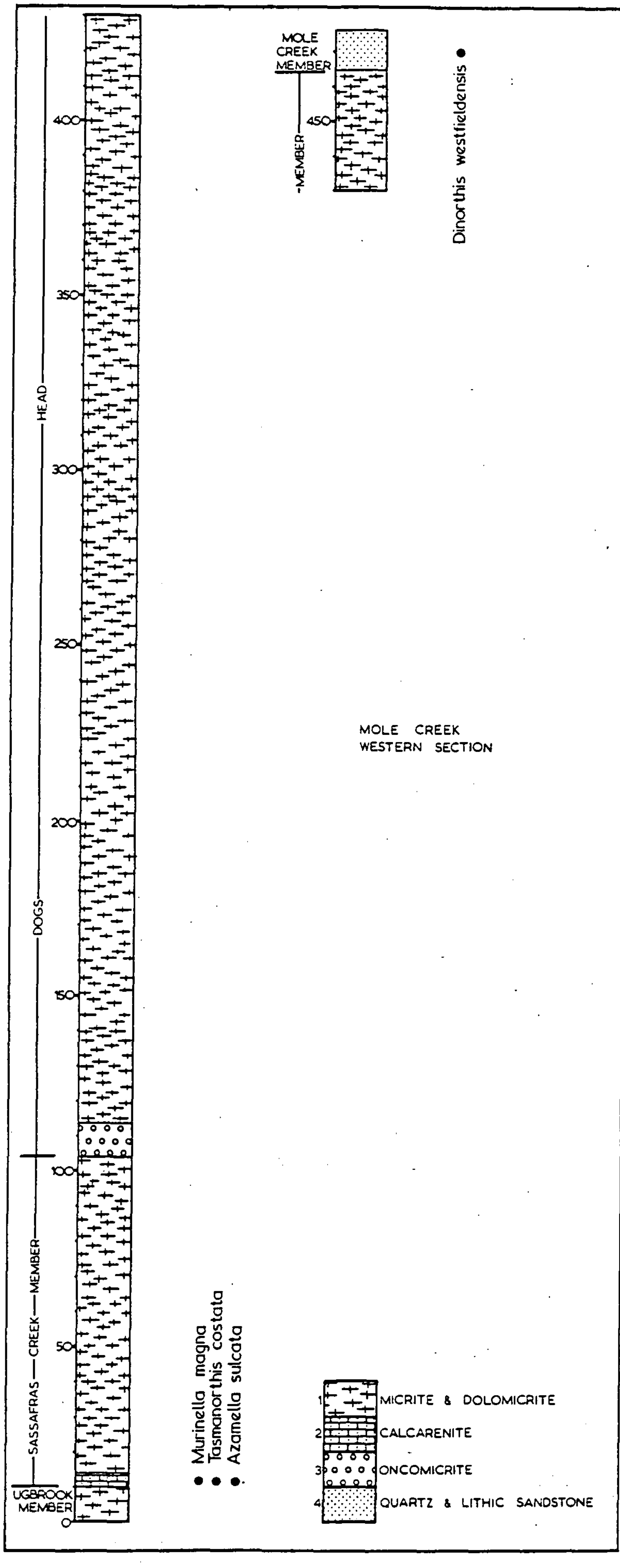

MOLE CREEK
EASTERN SECTION
OVERFLOW CREEK MEMBER
MOLE CREEK MEMBER
HEAD MEMBER
DOGS
SASSAFRAS CREEK MEMBER
UGBROOK MEMBER
STANDARD HILL MEMBER
40 m gap
Hesperorthis longirostroides
Lepidomena pulchra
Rhynchotrema bailliei
?Oepikina sp.
Chaganella sp.
Murinella magna
Tasmanorthis costata
Rhynchonellide gen. et sp. indet.
Holtedahlina sp.
Dinorthis westfieldensis
1 MICRITE & DOLOMICRITE
2 ONCOMICRITE
3 NODULAR MICRITE
4 CALCARENITE
5 SILTSTONE
6 SANDSTONE

Figure 4.5. Western section of the lower Chudleigh Limestone with ranges of brachiopods (lithostratigraphy adapted from Burrett, 1978, unpubl. Ph.D. thesis).



MOLE CREEK MEMBER
450
-MEMBER
Dinorthis westfieldensis
400
350
300
250
200
150
100
50
0
SASSAFRAS — CREEK — MEMBER — DOGS — HEAD
UGBROOK MEMBER
MOLE CREEK
WESTERN SECTION
Murinella magna
Tasmanorthis costata
Azamella sulcata
1 MICRITE & DOLOMICRITE
2 CALCARENITE
3 ONCOMICRITE
4 QUARTZ & LITHIC SANDSTONE

CHAPTER FIVE

SOUTH COAST AND PICTON RIVER AREAS

SOUTH COAST AREA

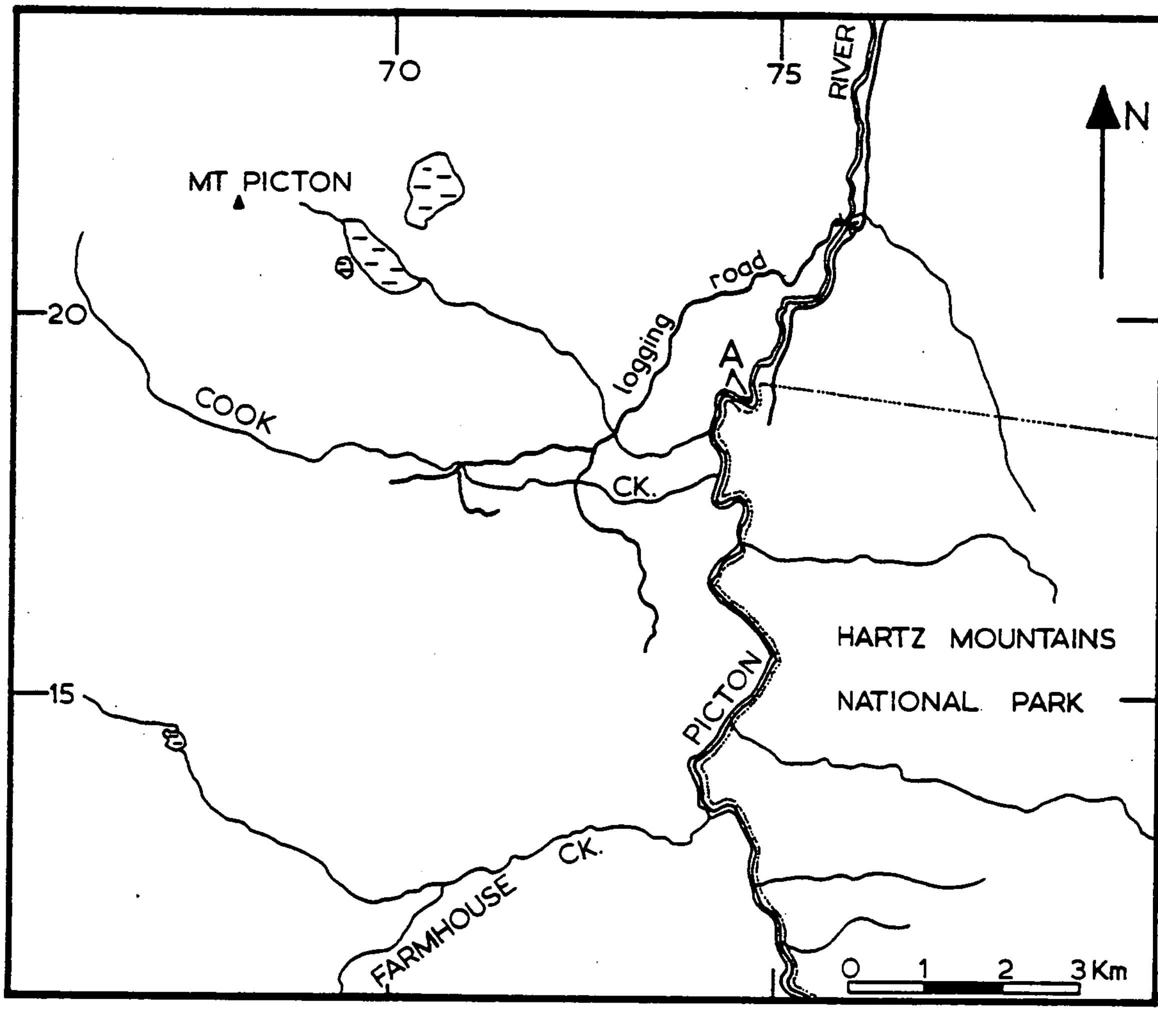
Ordovician carbonates occur in several localities along the south coast of Tasmania. These outcrops are discussed fully in appendix 2.

PICTON RIVER

Here the Gordon Subgroup sediments occur as isolated outcrops of carbonates and calcareous siltstones on the banks of the Picton River, 60 kilometres southwest of Hobart near the northwestern corner of the Hartz Mountains National Park (fig 5.1). These outcrops have only recently been discovered and they were first studied, and their conodont faunas described, by Burrett (1978 unpubl. Ph. D. thesis). The basal unit of the short section is a stromatoporoid - tabulate coral micrite. Overlying this is a thinner unit of nodular silty micrite with a coarsely silicified fauna of orthide, rhynchonellide and atrypide brachiopods.

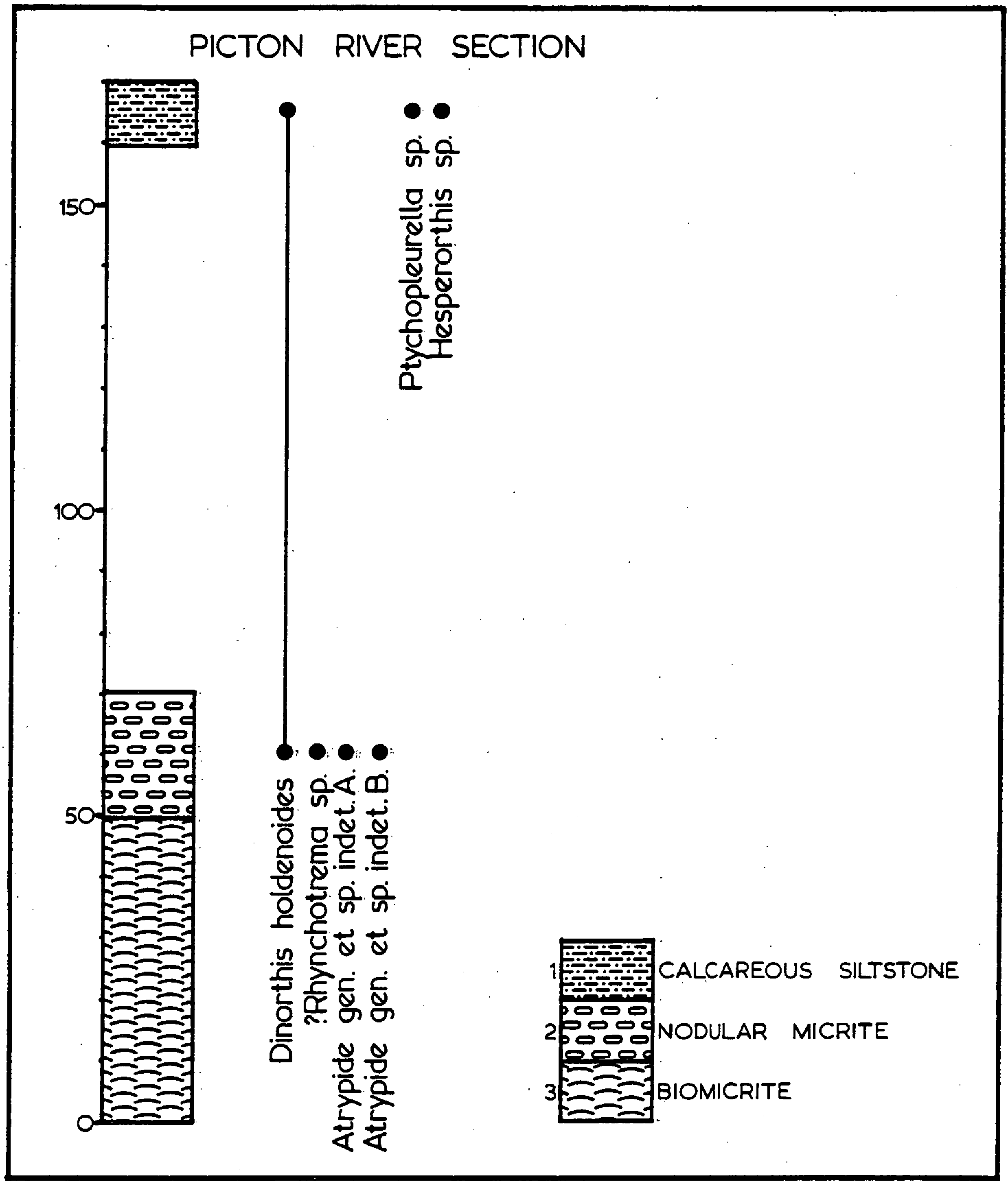
Overlying this nodular unit above a gap of about 90 metres is a small outcrop of dark silicified calcareous siltstone containing a well preserved but sparse orthide fauna. The section of the Picton River outcrops and the ranges of their included brachiopod faunas are presented graphically in figure 5.2.

Figure 5.1. Location of two isolated outcrops of Gordon Subgroup carbonates (locality A) along Picton River.



70
75
RIVER
N
MT PICTON
logging
road
20
A
COOK
CK.
HARTZ MOUNTAINS
NATIONAL PARK
PICTON
15
CK.
FARMHOUSE
0
1
2
3 Km

Figure 5.2. Section through Gordon Subgroup sediments along Picton River with ranges of associated brachiopods.


PICTON RIVER SECTION
150
100
50
0
Dinorthis holdenoides
?Rhynchotrema sp.
Atrypide gen. et sp. indet. A.
Atrypide gen. et sp. indet. B.
Ptychopleurella sp.
Hesperorthis sp.
1 CALCAREOUS SILTSTONE
2 NODULAR MICRITE
3 BIOMICRITE

CHAPTER SIX

BIOSTRATIGRAPHY

INTRODUCTION

A preliminary brachiopod biostratigraphy of the Ordovician and earliest Silurian has been erected. This has been made possible by the ubiquitous nature of the brachiopods. They, along with the trilobites are the most widespread faunal elements in the Ordovician and Early Silurian.

Numerous previous attempts have been made at a biostratigraphic zonation of the Tasmanian Ordovician. These have been by Corbett and Banks (1974), who gave a general overview of the faunal succession in the Florentine Valley area with particular reference to corals, trilobites and stromatoporoids; Burrett (1978 unpubl. Ph. D. thesis) who characterised 6 conodont assemblage zones ranging from Middle to Late Ordovician; Stait and Laurie (1980) who characterised 7 trilobite - brachiopod faunas in the Florentine Valley Formation; Banks and Burrett (1980) who based their treatment on the work of Burrett (op. cit.) and Stait and Laurie (op. cit.) with much additional trilobite, coral and graptolite data, and finally by Stait (1981 unpubl. Ph. D. thesis) who characterised 6 nautiloid assemblages in the Gordon Subgroup.

The zones herein are Range Zones and Overlap Range Zones *sensu* Johnson (1979). For the sake of convenience the upper boundary of a zone is defined at the lowest occurrence of the overlying zonal index. In some cases, notably in the upper portions of the Benjamin Limestone in the Florentine Valley it is difficult to justify a formal zonation as it is based on so few fossiliferous horizons.

Correlations to other parts of Australia are difficult because the Ordovician articulate brachiopod faunas throughout mainland Australia are poorly known, though some work on New South Wales Late Ordovician faunas has recently been completed by Percival (1979a, 1979b, 1980 unpubl. Ph. D. thesis). Australian correlations are usually accomplished by resorting to graptolite and conodont data. For correlations outside Australia, conodont evidence is usually relied upon as the brachiopods are almost all endemic species. However, some correlations can be made using data from apparently short-lived genera.

BRACHIOPOD ZONES

Apheoorthis humboldtensis zone

The base of this zone is defined as the lowest occurrence of *Apheoorthis humboldtensis* Laurie 1980. Also present in this zone is the inarticulate brachiopod *Westonia* sp., and the trilobites *Hystricurus* sp. nov., *Dikelocephalina* sp. nov., *Nyaya* sp. nov., and the graptolite *Psigraptus* sp. (Rickards & Stait in prep.).

This fauna has been found only in the Pontoon Hill Siltstone Member of the Florentine Valley Formation (see Appendix 1).

The *Apheoorthis* - *Nyaya* association also occurs in the Algain formation of the Inania Stage of the Siberian Platform. (Sokolov et al 1960; Rozova 1968; Chugaeva 1976) The presence of *Psigraptus* sp. indicates a correlation with the La 1.5 zone (Early Tremadoc) of Cooper (1979) which he correlates with the *Clonograptus aureus* & lowest *Kiaerograptus antiquus* zones in the Yukon (Jackson, 1974, 1975). Barnes *et al*. (1976) correlate this with conodont fauna B of Ethington & Clark (1971). The brachiopod zone correlates with assemblages 2b and 3 of Stait & Laurie (1980) and with assemblages 2 and 3 of Banks and Burrett, 1980.

Nanorthis carinata zone

The base of this zone is defined as the lowest occurrence of *Nanorthis carinata* Laurie, 1980. Also present in this zone are the brachiopod *Apheoorthis humboldtensis* (in basal portion only), trilobites *Parapilekia* sp. nov., *Asaphopsis juneensis* Kobayashi, *Megistaspis* (*Ekeraspis*) cf. *saltaensis*, ?*Pliomerina subquadrata* (Kobayashi), *Hystricurus lewisi* (Kobayashi) and the graptolite *Clonograptus rigidus* Hall.

This fauna has been found only in the upper Pontoon Hill Siltstone Member (Gordon Road and Gap Sections) and in the basal Mt Field Siltstone Member (Gap Section) of the Florentine Valley Formation (see Appendix 1).

Correlation of this zone with the La 2 (Late Tremadoc) zone of Cooper (1979) is indicated by the presence of _Clonograptus rigidus_. Cooper correlates this zone with the bulk of the _Kiaerograptus antiquus_ zone in the Yukon which Barnes _et al._ (1976) correlates with conodont fauna C of Ethington & Clark (1971). This brachiopod zone is equivalent to assemblage 4 of Stait & Laurie (1980) and assemblage 4 of Banks and Burrett (1980).

Tritoechia lewisi zone

The base of this zone is defined as the lowest occurrence of _Tritoechia lewisi_ Brown 1948. Also present in this zone is the brachiopod _Syntrophopsis karmbergi_ Brown 1948 and the trilobites ?_Pliomerina subquadrata_ (Kobayashi), _Hystricurus lewisi_ (Kobayashi), gen. et sp. nov. cf. _Tasmanocephalus_, _Selenoharpes_ sp., _Megistaspis_ (?_Ekeraspis_) sp. nov. and _Asaphopsis_ sp. nov.

This fauna is found in the Florentine Valley area in the Pontoon Hill Siltstone Member (Gordon Road Section) and in the Mount Field Siltstone Member (Gap Section) (see Appendix 1).

This zone is equivalent to assemblage 5 of Stait & Laurie (1980) and to assemblage 5 of Banks & Burrett (1980).

<u>Tritoechia</u> <u>florentinensis</u> zone

The base of this zone is defined as the lowest occurrence of *Tritoechia florentinensis* Laurie 1980. Also present in this zone are the trilobites *Hystricurus lewisi* (Kobayashi), ?*Pliomerina subquadrata* (Kobayashi) and *Asaphopsis* sp. nov.

This fauna has only been found in the Florentine Valley, in the Mount Field Siltstone Member of the Florentine Valley Formation (see Appendix 1).

This zone is equivalent to assemblage 6 of Stait & Laurie (1980) and assemblage 6 of Banks & Burrett (1980).

?<u>Tritoechia</u> <u>careyi</u> zone

The base of this zone is defined as the lowest occurrence of ?*Tritoechia careyi* Brown 1948. Also present in this zone are the trilobites *Hystricurus lewisi* (Kobayashi), ?*Pliomerina subquadrata* (Kobayashi) and *Asaphopsis* sp. nov. and the graptolites *Didymograptus gracilis* and *Didymograptus* cf. *mundus*.

This fauna has been found only in the Florentine Valley, within the Mount Field Siltstone Member of the Florentine Valley Formation.

The graptolite Didymograptus gracilis is found in the Chewtonian and early Castlemainian of Victoria as is Didymograptus mundus.

This zone is equivalent to assemblage 7 of Stait & Laurie (1980) and assemblage 7 of Banks & Burrett (1980).

Leptella corbetti zone

The base of this zone is defined as the lowest occurrence of Leptella corbetti sp. nov. Also present in this zone are the brachiopods Tritoechia karmbergensis Laurie 1980, Archaeorthis subcarinata Laurie 1980, the trilobites Geragnostus sp., Dimeropygiella sp. ?Carolinites sp., Tasmanocephalus ?stephensi (Etheridge), Selenoharpes sp. and Canningella sp., the cephalopod Piloceras tasmaniense Teichert and the graptolites Phyllograptus anna and Phyllograptus ilicifolius.

This fauna has been found only in the Florentine Valley area in the lowermost Karmberg Limestone at the intersection of Nine Road and Florentine Road, at the Gap (see Appendix 1) and also along Sunshine Road.

Recently, silicified fragments of *Leptella corbetti* sp. nov. have been found in the basal limestone lens of the Karmberg Limestone at the Gap (Stait pers. comm., Oct. 1981) in association with the conodonts *Prioniodus intermedius* and *Juanognathus variabilis* (Burrett pers. comm.). These conodonts indicate a correlation with the late Canadian *Prioniodus evae* zone of Lindström 1971 (Fauna E of Ethington & Clark 1971).

The trilobites *Canningella* and *Carolinites* appear with *Prioniodus evae* in fauna 3b of the Canning Basin (Legg 1978). McTavish (1973) correlated this fauna with conodont fauna E of Ethington & Clark (1971).

The graptolite *Phyllograptus anna* is found in faunas 3c and 3d of the Canning Basin (Legg *op. cit.*). Legg believed Faunas 3c and 3b (see above) to be of "approximately the same age" (p 325).

Phyllograptus anna is also found in the *Didymograptus nitidus* and *Isograptus gibberulus* zones of the Skiddaw Group of Cumberland, England (Jackson, 1962). These zones are correlated with the Chewtonian and Castlemainian of the Victorian graptolite sequence (Strachan in Williams *et al.*, 1972).

Phyllograptus ilicifolius is also found in the Chewtonian of Victoria (Thomas, 1960).

This brachiopod zone correlates with the "fauna containing _Leptella_ sp. nov." in Stait & Laurie (1980) and with assemblage 8 of Banks & Burrett (1980).

The top of this zone must remain undefined because of the great thickness of apparently unfossiliferous limestones and siltstones occurring in the Florentine Valley between the few horizons belonging to this zone and the late Whiterock zone of _Aporthophyla staiti_.

Hesperonomiella jurikae zone

The base of this zone is defined as the lowest occurrence of _Hesperonomiella jurikae_ sp. nov.. Also present in this zone is the trilobite _Asaphellus ?lewisi_ Kobayashi and indeterminate ostracodes.

This zone is the oldest brachiopod fauna found in the areas of northern Tasmania examined by the author and has been found in both the Eugenana and Railton area (see Chapter 3).

The zone has not been found in the Florentine Valley and as such cannot be directly correlated with that sequence. It is assumed that the _Hesperonomiella jurikae_ zone and the succeeding _Railtonella scanloni_ zone correlate with the "barren zone" between the faunas of the _Leptella corbetti_ zone and the _Aporthophyla staiti_ zone in the Florentine Valley sequence although their exact relationship to the L. corbetti zone is unknown.

The genus Hesperonomiella has only been found in rocks of Whiterock age (Ulrich & Cooper, 1938; Cooper, 1956a; Bates, 1968; Neuman & Bates, 1978; Williams, 1972; Jensen, 1967). Such an age for the H. jurikae zone would to some degree support its correlation with the "barren zone" in the middle Karmberg Limestone of the Florentine Valley.

Railtonella scanloni zone

The base of this zone is defined as the lowest occurrence of Railtonella scanloni gen. et sp. nov. Also present in this zone is the brachiopod Hesperonomiella jurikae, the trilobite Asaphellus ?lewisi Kobayashi and indeterminate ostracodes.

This zone is represented in both the Railton and Eugenana areas but is absent from the Florentine Valley area. As it is found immediately below the Aporthophyla staiti zone at Eugenana it is assumed to correlate with the upper reaches of the "barren zone" immediately below the A. staiti zone in the Karmberg Limestone of the Florentine Valley sequence.

The only other occurrence of this genus is that of R. sinensis (Xu et al., 1974) from the Shizipu Formation of Guizhou Province, China.

Both of the above zones (*H. jurikae* and *R. scanloni*) are younger than assemblage 8, and older than assemblage 9 of Banks & Burrett 1980.

Aporthophyla staiti zone

The base of this zone is defined as the lowest occurrence of *Aporthophyla staiti* sp. nov.

Other brachiopods (orthide gen. et sp. indet. and porambonitacean gen. et sp. indet.) also occur in this zone, as do the trilobites ?*Pliomerina subquadrata* (Kobayashi), *Etheridgaspis* sp., *Carolinites bulbosa* Kobayashi, *Asaphellus lewisi* Kobayashi, ?*Bathyuriscops* sp. and *Tasmanocephalus stephensi* (Etheridge), the gastropod *Teiichispira* sp. and the cephalopods *Wutinoceras paucicubiculatum* Teichert & Glenister and *Adamsoceras johnstoni* (Teichert & Glenister).

This fauna is best represented in the Railton and Eugenana areas (see Chapter 3). The faunas described by Etheridge (1883) and Kobayashi (1940b) from Caroline Creek belong to this zone. The zone is poorly represented in the Florentine Valley, at Manning Road and Sunshine Road (see Chapter 2).

At Railton *A. staiti* is found above and below the limestone at Blenkhorn's Quarry. It is in this limestone the two cephalopod species (see above) are found. They are regarded by Flower (1976) as Whiterock in age.

At Manning Road in the Florentine Valley *A. staiti* is found in association with *Histiodella sinuosa* (Graves & Ellison) which is found in conodont fauna 3 and lower fauna 4 of Sweet & Bergstrom (1976).

This zone correlates with assemblages 8b and 9, but not with assemblage 8 of Banks & Burrett (1980).

Leptellina sulcata zone

The base of this zone is defined as the lowest occurrence of *Leptellina sulcata* sp. nov.. Also occurring in this zone is another brachiopod (strophomenacean gen. et sp. indet) and an indeterminate asaphid trilobite.

This fauna has been found only in the Manning Road Section in the Florentine Valley (see Chapter 2) where it spans the Karmberg Limestone - Cashions Creek Limestone boundary.

This zone in essence forms the boundary between assemblages 9 and 10 of Banks & Burrett 1980.

Lepidomena fortimuscula zone

The base of this zone is defined as the lowest occurrence of Lepidomena fortimuscula gen et sp. nov.. The zone also contains the brachiopods Rhynchotrema bailliei sp. nov., Apatomorpha melrosensis sp. nov. ?Strophomena sp., Bellimurina cf. compressa Cooper, Hesperorthis longirostroides sp. nov., Dactylogonia rara sp. nov., Chaganella sp., Maydenella asymmetrica gen. et sp. nov., Teratelasmella plicata gen. et sp. nov., oepikinid gen et sp indet., ?Ptychopleurella sp, orthide gen. et sp. indet. with fragmentary trilobites (asaphids and raphiophorids), gastropods (including Raphistoma sp and Maclurites florentinensis Banks & Johnson.) bivalves, rostroconchs, cephalopods (including Discoceras sp and Gorbyoceras sp), echinoderm ossicles, sponges, bryozoans, stromatoporoids and algae (Girvanella sp.). This fauna is widespread in the Florentine Valley area, occupying as it does most, if not all, of the Cashions Creek Limestone wherever that formation outcrops. The fauna is also found in northern Tasmania in and immediately below the limestone at Melrose (near Eugenana).

A more detailed discussion of some aspects of the palaeoecology of this fauna can be found in Chapter 8.

In the Cashions Creek Limestone of the Florentine Valley and in the limestones at Melrose are found the conodonts Phragmodus flexuosus, Belodina alabamensis, *Appalachignathus* sp, *Drepanoistodus forceps* and *Belodella copenhagenensis*. This conodont fauna has been correlated by Burrett (1978 unpubl. Ph. D. thesis) with faunas 5 and 6 of Sweet & Bergström (1976). This brachiopod zone correlates with assemblage 10 and lower assemblage 11 of Banks & Burrett 1980.

This zone can be divided into two acme subzones; the lower, characterised by the predominance of *Apatomorpha melrosensis* sp. nov., is restricted to the base of the zone whilst the upper, characterised by the predominance of the nominal species (*L. fortimuscula*), occupies by far the largest portion of the zone. The lower of the two subzones is well represented in the siliciclastics below the limestone at Melrose (near Eugenana) and in the basal Cashions Creek Limestone of the Manning Road section in the Florentine Valley. The genus *Apatomorpha* has previously only been recorded from the Athens Formation in Tennessee, U.S.A.

Lepidomena pulchra zone

The base of this zone is defined as the lowest occurrence of *Lepidomena pulchra* gen. et sp. nov. This zone also contains the brachiopods *Oepikina banksi* sp. nov., *Hesperorthis longirostroides* sp. nov. ?*Rhynchotrema* sp., *Rhynchotrema bailliei* sp. nov., *Azamella* sp. and *Chaganella* sp., fragmentary trilobites, gastropods and bivalves.

This fauna has been found in the Florentine Valley in the basal Lower Limestone Member of the Benjamin Limestone, and in the Mole Creek area, throughout the Ugbrook Member of the Chudleigh Limestone.

The presence of Chirognathus monodactyla and Plectodina aculeata in the upper two thirds of the Ugbrook Member (Burrett 1978 unpubl. Ph. D. thesis) indicate a correlation with conodont fauna 7 of Sweet & Bergstrom (1976) for at least the upper part of the zone.

In the Florentine Valley the conodont Chirognathus monodactyla does not appear until the succeeding brachiopod zone (Tasmanorthis calveri zone) and Plectodina aculeata does not appear until much later. This is probably more an artefact of the general rarity of conodonts rather than diachroneity in the faunal dispersion.

The genus Lepidomena is very similar to Ishimia Nikitin 1974, which is found in the Karakan, Tselinograd and Yerkebidiak horizons in the Middle Ordovician of Kazakhstan. The genus Chaganella Nikitin 1974 has previously only been recorded from the Tselinograd horizon of Kazakhstan.

This brachiopod zone correlates with upper assemblage 11 and lower assemblage 12 of Banks & Burrett (1980).

Tasmanorthis calveri zone

The base of this zone is defined as the lowest occurrence of *Tasmanorthis calveri* gen. et sp. nov.. This zone also contains the brachiopods *Azamella rotunda* gen. et. sp. nov. and *Rhynchotrema ponderosa* sp. nov. with fragmentary trilobites.

This fauna has been found only in the Florentine Valley, in the lower portion of the Lower Limestone Member of the Benjamin Limestone.

The conodont fauna here contains *Tasmanognathus careyi* Burrett 1979, *Erismodus gracilis* and *Chirognathus monodactyla* which were correlated with fauna 7 of Sweet and Bergström (1976) by Burrett (1978, 1979).

This brachiopod zone can be correlated with the upper part of assemblage 12 of Banks & Burrett 1980.

Tasmanorthis costata zone

The base of this zone is defined as the lowest occurrence of *Tasmanorthis costata* gen. et. sp. nov.. Also present in this zone are *Azamella sulcata* gen. et sp. nov., *Macrocoelia stenomuscula* sp. nov. *Skenidioides alatus* sp. nov., *Ptychopleurella magna* sp. nov., *Rhynchotrema crossi* sp. nov. and *Murinella magna* sp. nov..

This fauna is very well represented both in the Florentine Valley and at Mole Creek. In the former area it occupies the middle of the Lower Limestone Member of the Benjamin Limestone and in the latter area it occupies the Sassafras Creek Member and lower Dogs Head Hill Member of the Chudleigh Limestone.

In the Florentine Valley the conodont fauna found in the lower part of this zone includes Chirognathus monodactyla, Drepanoistodus suberectus, Erismodus gracilis, Phragmodus tasmaniensis Burrett MS., Panderodus serpaglii Burrett MS and Tasmanognathus careyi Burrett 1979. Such a conodont fauna correlates with fauna 7 or lower fauna 8 of Sweet & Bergström (1976) (Burrett 1978 unpubl. Ph. D. thesis). The upper part of this zone in this area is barren of conodonts.

In the Chudleigh Limestone at Mole Creek the base of this zone is largely barren of conodonts (only Plectodina aculeata occurring). Above this portion of the zone Phragmodus undatus appears, indicating a correlation with fauna 8 of Sweet & Bergström 1976. Toward the top of the zone Plectodina aculeata disappears, indicating a possible correlation of the top of the zone with basal fauna 9 of Sweet & Bergström (op. cit.).

This brachiopod zone is correlated with part of assemblage 14 of Banks & Burrett 1980.

Strophomena cf. *oklahomensis* zone

The base of this zone is defined as the lowest occurrence of *Strophomena* cf. *oklahomensis* Cooper 1956. Also found in this zone are the brachiopods *Tasmanorthis costata* gen. et sp. nov., *Ptychopleurella* cf. *magna* sp. nov., *Azamella sulcata* and atrypide gen. et. sp. indet. with the trilobites *Codonocalymene* gen. et. sp. nov. (Banks MS.), ceraurid gen. et. sp. indet., and ?*Pseudobasilicus* sp.

This zone has only been found in the Florentine Valley area in the upper portion of the Lower Limestone Member of the Benjamin Limestone.

No conodonts have been found associated with this fauna so no direct correlations can be made.

Strophomena oklahomensis Cooper is found in the Pooleville Member of the Bromide Formation, Oklahoma. Sweet and Bergström (1976) correlate this unit with their conodont fauna 7. This is probably slightly older than the occurrence of *Strophomena* cf. *oklahomensis* Cooper in Tasmania.

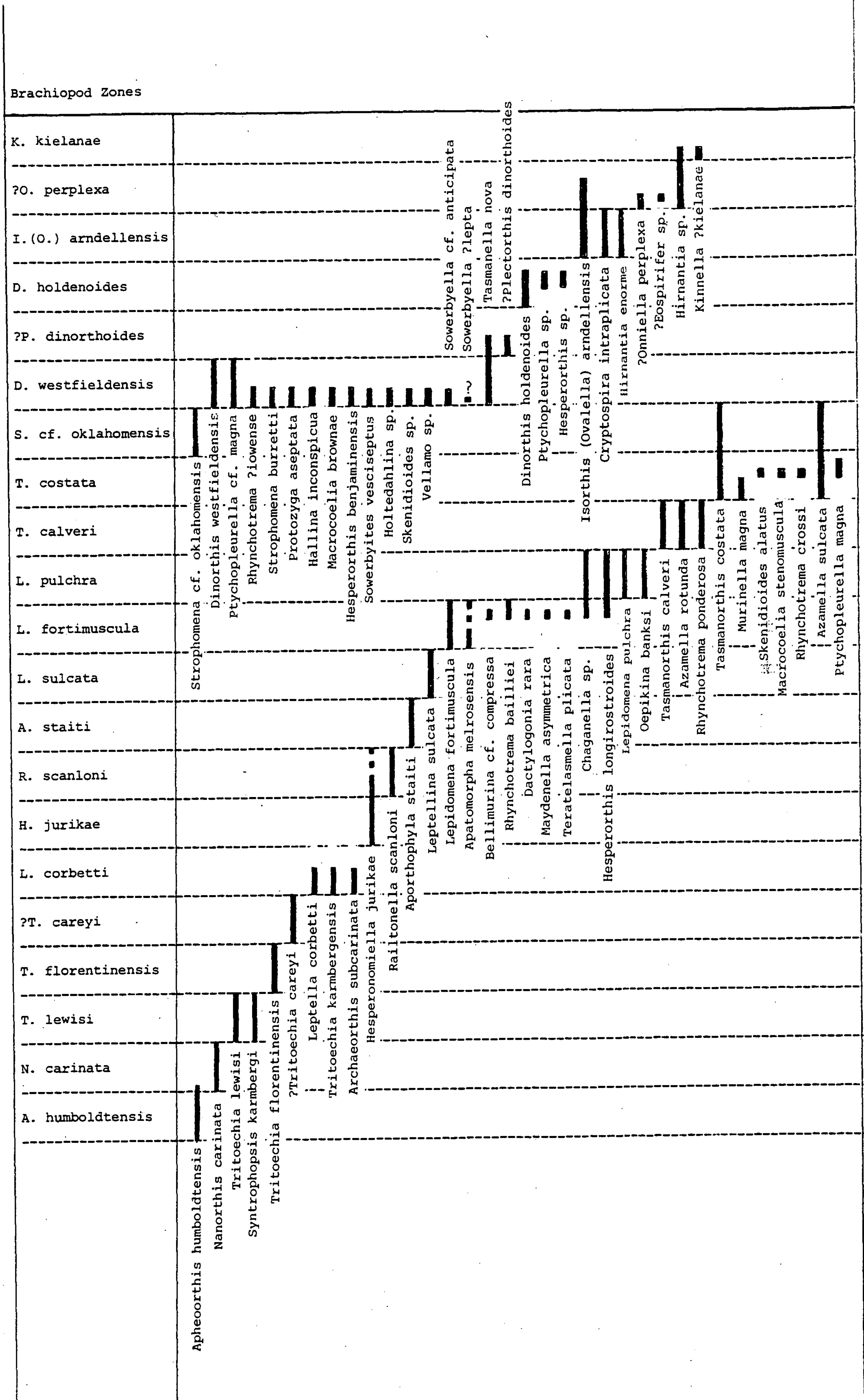
Dinorthis westfieldensis zone

The base of this zone is defined as the lowest occurrence of *Dinorthis westfieldensis* sp. nov. Also present in this zone are the brachiopods *Strophomena* burretti sp. nov., Rhynchotrema ?iowense Wang, Protozyga aseptata sp. nov., Hallina inconspicua sp. nov. Macrocoelia brownae sp. nov., Tasmanella nova gen. et sp. nov. Ptychopleurella cf. magna sp. nov., Hesperorthis benjaminensis sp. nov., Sowerbyites vesciseptus Percival, Holtedahlina sp., Skenidioides sp., ?Leptellina sp., Vellamo sp. (= Clitambonites (Clitambonites) sp. in Burrett, Laurie & Stait, 1981, see Appendix 2), Sowerbyella cf. anticipata Percival, Sowerbyella ?lepta Percival and leptellinid gen. et. sp. nov.. Trilobites occurring in this zone are Pliomerina sp., Remopleurides ?saenuros Webby, Amphilichas encyrtos Webby and an indeterminate illaenid.

This fauna is found in the Florentine Valley (uppermost Lower Limestone Member, Lords Siltstone Member and lowermost Upper Limestone Member); in the Mole Creek area (upper Dogs Head Member and Mole Creek Member); at Precipitous Bluff (basal Precipitous Bluff Beds) and at Point Cecil (see Appendix 2).

In the Florentine Valley this zone contains the conodonts Belodina compressa, Bryantodina abrupta, Phragmodus undatus and Plectodina aculeata. This assemblage, coupled with the absence of Plectodina cf furcata indicates a correlation with fauna 8 of Sweet and Bergström (1976) (Burrett 1978 unpubl. Ph. D. thesis).

Figure 6.1. Zonal distribution of Ordovician and Early Silurian articulate brachiopods of Tasmania.



Brachiopod Zones
K. kielanae
?O. perplexa
I.(O.) arndellensis
D. holdenoides
?P. dinorthoides
D. westfieldensis
S. cf. oklahomensis
T. costata
T. calveri
L. pulchra
L. fortimuscula
L. sulcata
A. staiti
R. scanloni
H. jurikae
L. corbetti
?T. careyi
T. florentinensis
T. lewisi
N. carinata
A. humboldtensis
Apheoorthis humboldtensis
Nanorthis carinata
Tritoechia lewisi
Syntrophopsis karmbergi
Tritoechia florentinensis
?Tritoechia careyi
Leptella corbetti
Tritoechia karmbergensis
Archaeorthis subcarinata
Hesperonomiella jurikae
Railtonella scanloni
Aporthophyla staiti
Leptellina sulcata
Lepidomena fortimuscula
Apatomorpha melrosensis
Bellimurina cf. compressa
Rhynchotrema bailiei
Dactylogonia rara
Maydenella asymmetrica
Teratelasmella plicata
Chaganella sp.
Hesperorthis longirostroides
Lepidomena pulchra
Oepikina banksi
Tasmanorthis calveri
Azamella rotunda
Rhynchotrema ponderosa
Tasmanorthis costata
Murinella magna
Skenidioides alatus
Macrocoelia stenomuscula
Rhynchotrema crossi
Azamella sulcata
Ptychopleurella magna
Strophomena cf. oklahomensis
Dinorthis westfieldensis
Ptychopleurella cf. magna
Rhynchotrema ?iowense
Strophomena burretti
Protozyga aseptata
Hallina inconspicua
Macrocoelia brownae
Hesperorthis benjaminensis
Sowerbyites vesciseptus
Holtedahlina sp.
Skenidioides sp.
Vellamo sp.
Sowerbyella cf. anticipata
Sowerbyella ?lepta
Tasmanella nova
?Plectorthis dinorthoides
Dinorthis holdenoides
Ptychopleurella sp.
Hesperorthis sp.
Isorthis (Ovalella) arndellensis
Cryptospira intraplicata
Hirnantia enorme
?Onniella perplexa
?Eospirifer sp.
Hirnantia sp.
Kinnella ?kielanae

At Mole Creek, Plectodina cf. furcata also occurs in this zone indicating a possible correlation with fauna 9 of Sweet and Bergström (1976). Again the absence of P. cf. furcata in this zone in the Florentine Valley is thought to be an artefact of the general rarity of conodonts. This assertion is supported by the fact that P. cf. furcata and Oulodus cf. oregonia appear in the sequence at about the same level whereas in the American midcontinent sequence the incoming of P. furcata marks the base of fauna 9 and O. oregonia the base of fauna 11.

This zone correlates with assemblage 15 and possibly 16 of Banks & Burrett 1980.

?Plectorthis dinorthoides zone.

The base of this zone is defined as the lowest occurrence of ?Plectorthis dinorthoides sp. nov.. Also present in this zone are Tasmanella nova gen. et. sp. nov., numerous gastropods, bivalves and some fragmentary trilobites.

This zone is poorly represented and occurs only in the Westfield section of the Benjamin Limestone in the Florentine Valley. It occurs at the top of a considerable thickness of limestone which is barren of conodonts, thus no direct correlation can be made. However, Oulodus cf. oregonia is found in the overlying brachiopod zone, Plectodina aculeata in the underlying zone, and *Belodina compressa* both above and below. This virtually restricts the possible correlation of this zone with faunas 8, 9, 10 or possibly 11 of Sweet & Bergström (1976).

This zone probably correlates with assemblages 17 and 18 of Banks & Burrett 1980.

Dinorthis holdenoides zone

The base of this zone is defined as the lowest occurrence of *Dinorthis holdenoides* sp. nov.. Also present in this zone are the brachiopods *Rhynchotrema* sp., a small atrypide (gen. et. sp. indet. A), a large atrypide (gen. et. sp. indet. B), *Ptychopleurella* sp. and *Hesperorthis* sp.

This zone is represented in the Florentine Valley (upper Limestone Member) by the nominal species only, but in the Picton River section all the above species occur. In the Florentine Valley this zone occurs in the upper half of the Upper Limestone Member in the Westfield Section and fragments of *D. holdenoides* have been found in the Upper Limestone Member immediately below the Westfield Sandstone along Stan Murray Road.

In the Florentine Valley the conodonts *Plectodina furcata* and *Oulodus* cf. *oregonia* occur in this zone. In the Picton River section the conodont fauna includes the above forms as well as *Phragmodus undatus* and *Oulodus* *robustus*. Burrett (1978 unpubl. Ph. D. thesis) correlated this assemblage with fauna 11 of Sweet & Bergström (1976).

This brachiopod zone correlates with assemblages 19 and 20 of Banks and Burrett (1980).

This latter fauna (OT 20) was recorded from the basal Westfield Sandstone near Westfield Quarry (Florentine Valley). It contains trilobites, bivalves and some brachiopods, the latter being quite rare. The outcrops from which this fauna was originally collected are now overgrown and very deeply weathered, preventing any further useful collecting. Therefore this assemblage is, by definition, included in the *Dinorthis holdenoides* zone. Banks and Burrett assigned an Ordovician age to the assemblage.

Isorthis (*Ovalella*) *arndellensis* zone

The base of this zone is defined as the lowest occurrence of *Isorthis* (*Ovalella*) *arndellensis* sp. nov.. Also occurring in this zone is *Cryptospira intraplicata* gen. et. sp. nov., *Hirnantia enorme* sp. nov., solitary rugose corals, crinoids and rare gastropods.

This zone is found in the Florentine Valley, in and near Westfield Quarry and a short distance (30 m) above the base of the Westfield Sandstone at Stan Murray Road.

Figure 6.2. Correlation of Tasmanian Ordovician and Lower Silurian brachiopod zones (column 1) with other Tasmanian biostratigraphic schemes (columns 2, 3), with American conodont assemblages (columns 4, 5) and with the Victorian Ordovician graptolite sequence (column 6).

This paper Brachiopod Zones	Stait & Laurie 1980 Brachiopod-Trilobite Assemblages	Banks & Burrett 1980 Tasmanian Faunal Assemblages	Sweet & Bergstrom 1976 Midcontinent Conodont Assemblages	Ethington & Clark 1971 Conodont Assemblages	Victorian Stages
K. kielanae					
?*O. perplexa*		ST1			
I. (*O.*) *arndellensis*					
D. holdenoides		OT20 OT19	12 11		
?*P. dinorthoides*		OT18 OT17	10		
D. westfieldensis		OT16 OT15	9		
S. cf *oklahomensis*					
T. costata		OT14	8		
T. calveri					
L. pulchra		OT12	7		
L. fortimuscula		OT11 OT10	6 5		
L. sulcata			4		
A. staiti		OT9 OT8b	3		
R. scanloni					
H. jurikae					
L. corbetti		OT8		E	Castlemainian
?*T. careyi*	7	OT7			Chewtonian
T. florentinensis	6	OT6		D	Bendigonian
T. lewisi	5	OT5			Lancefieldian 3
N. carinata	4	OT4		C	Lancefieldian 2
A. humboldtensis	3 2b	OT3 OT2		B	Lancefieldian 1.5
	2a				

The zone has a distinctly Silurian aspect with the previous oldest recorded *Isorthis* (*Ovalella*) being Early Llandovery (Walmsley & Boucot 1975) and *Cryptospira* being very similar to *Megumatrypa* Harper 1973, an Early Silurian genus.

?*Onniella perplexa* zone

The base of this zone is defined by the lowest occurrence of ?*Onniella perplexa* sp. nov.. Also present in this zone are the brachiopods *Isorthis* (*Ovalella*) *arndellensis* sp. nov., ?*Eospirifer* sp. (see Sheehan & Baillie, 1981), *Hirnantia* sp. and an indeterminate leptaenid; the trilobites *Eokosovopeltis* sp. nov., *Bumastoides* sp. and ?*Encrinurus* sp., with bryozoans, bivalves and the graptolites *Glyptograptus persculptus*, *Climacograptus normalis*, *Atavograptus* sp. and ?*Akidograptus* sp. (Baillie, Banks & Rickards, 1978).

Baillie, Banks & Rickards believed this graptolite assemblage to correlate with the *G. persculptus* or lower *A. acuminatus* zones of the Llandovery. This zone corresponds to the ST1 assemblage of Banks & Burrett 1980.

This faunal assemblage is restricted to a fine grained unit of the Westfield Sandstone in the Florentine Valley. *I.* (*O.*) *arndellensis*, found in the sandstones below, does not occur in this finer unit but reappears in the overlying sandstone. The other species which characterise the I. (O.) arndellensis zone are not found above the finer grained unit. Therefore the ?O. perplexa assemblage, though apparently facies controlled marks a distinct change in faunal composition, at least on a local scale, and is herein designated a zone.

Kinnella ?kielanae assemblage

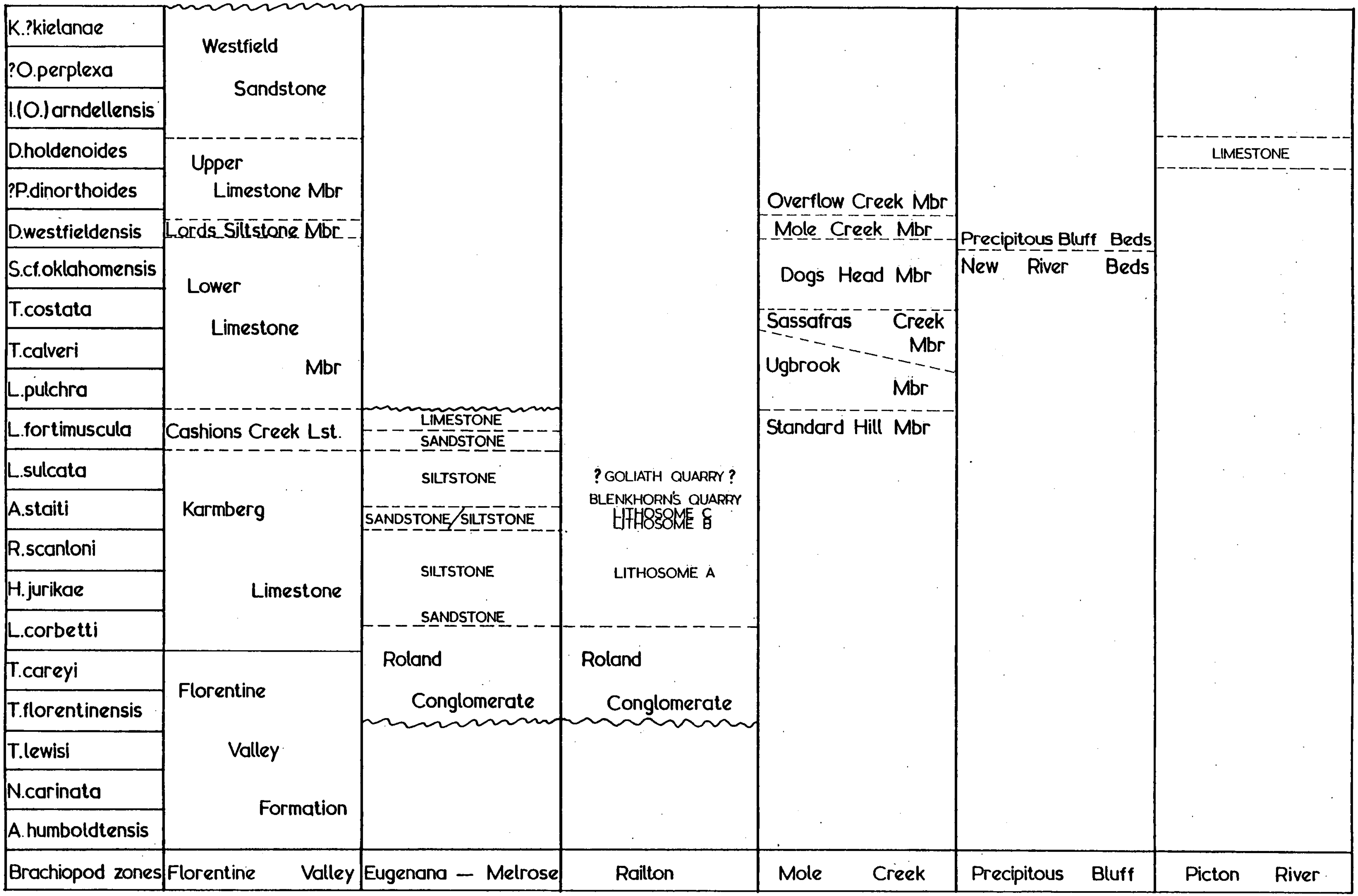
This assemblage is characterised by rare Kinnella ?kielanae (Temple), an unidentified leptaenid and common bryozoans. Only one horizon is known and this is found along the road to Westfield Quarry (Florentine Valley).

Kinnella kielanae (Temple) is a widespread species and has been reported from Poland, England and Wales (Temple, 1965; Wright, 1968) Sweden (Bergström, 1968b); Bohemia (Havlíček & Vanek, 1966; Marek & Havlíček 1967) and Quebec (Lesperance & Sheehan, 1976). This occurrence of Kinnella is the first record of this genus in association with or stratigraphically above definite Early Silurian graptolites (Baillie, Banks & Rickards, 1978)

SUMMARY

The sequence of Ordovician and Early Silurian brachiopod faunas of Tasmania has been divided into twenty zones with a further sparse assemblage overlying. Their names and the zonal distribution of their constituent brachiopods are summarised in fig 6.1. The

Figure 6.3. Correlation chart of studied sequences of the Tasmanian Ordovician and Lower Silurian succession. Correlations are based largely on brachiopod faunas with minor supplementary conodont data from Burrett (1978, unpubl. Ph.D. thesis).



Brachiopod zones
K.?kielanae
?O.perplexa
I.(O.) arndellensis
D.holdenoides
?P.dinorthoides
D.westfieldensis
S.cf.oklahomensis
T.costata
T.calveri
L.pulchra
L.fortimuscula
L.sulcata
A.staiti
R.scanloni
H.jurikae
L.corbetti
T.careyi
T.florentinensis
T.lewisi
N.carinata
A.humboldtensis
Florentine Valley
Westfield Sandstone
Upper Limestone Mbr
Lords Siltstone Mbr
Lower Limestone Mbr
Cashions Creek Lst.
Karmberg Limestone
Florentine Valley Formation
Eugenana — Melrose
LIMESTONE
SANDSTONE
SILTSTONE
SANDSTONE/SILTSTONE
SILTSTONE
SANDSTONE
Roland Conglomerate
Railton
? GOLIATH QUARRY ?
BLENKHORN'S QUARRY
LITHOSOME C
LITHOSOME B
LITHOSOME A
Roland Conglomerate
Mole Creek
Overflow Creek Mbr
Mole Creek Mbr
Dogs Head Mbr
Sassafras Creek Mbr
Ugbrook Mbr
Standard Hill Mbr
Precipitous Bluff
Precipitous Bluff Beds
New River Beds
Picton River
LIMESTONE

correlation of these zones with other biostratigraphic schemes for Tasmania, with American Midcontinent Conodont faunas and with the Victorian graptolite zonation are summarised in fig 6.2. The correlations of studied sequences, based largely on evidence form brachiopod faunas (with additional conodont evidence) is summarised in fig 6.3.

CHAPTER SEVEN

BIOGEOGRAPHY

INTRODUCTION

As it is beyond the scope of this study to indulge in a detailed biogeographic analysis of the Tasmanian faunas, they will only be briefly discussed in relation to the work of Williams (1973) with occasional reference to more recent data.

Williams divided his analysis into the time periods Arenigian, Llanvirn, Early Caradoc, Mid-Caradoc and Mid-Ashgill. In addition to these epochs, the Tremadoc will also be briefly surveyed. The correlation from the Tasmanian sequence to the British sequence is approximate and is based largely on Barnes *et al.* (1976) and Burrett (1978 unpubl. Ph. D. thesis).

TREMADOCIAN FAUNAS

Faunas of this age are not discussed in Williams (1973). Two genera of articulate brachiopod in the Tasmanian sequence can be assigned a Tremadoc age: *Apheoorthis* and *Nanorthis*. The former genus has been found in the Tremadoc in the U.S. (Ulrich & Cooper, 1938), Siberia (Yadrenkina, 1974), China (Wang, 1956) and possibly from Argentina (Harrington & Kay, 1951).

This distribution indicates a restriction of this genus to a Tremadocian precursor of Williams "American Realm". Nanorthis, on the other hand, has been found in the U.S. (Ulrich & Cooper, 1938), Siberia (Yadrenkina, 1974), China (Xu et al, 1974), Argentina (Harrington, 1938) and Bohemia (Havlíček, 1949a, 1977).

ARENIGIAN FAUNAS

Both Tritoechia and Archaeorthis are pandemic forms whilst Syntrophopsis and Leptella are restricted to the American Realm.

LLANVIRNIAN FAUNAS

Hesperonomiella is a pandemic genus whilst Aporthophyla is a form endemic to the American Realm. Railtonella has at present only been identified from Tasmania and Southwest China (see previous chapter).

EARLY CARADOCIAN FAUNAS

Pandemic forms are Hesperorthis, Bellimurina, Oepikina, Ptychopleurella, whilst Rhynchotrema, Dactylogonia and Apatomorpha are restricted to the the American Realm, the latter genus being previously known only from the U.S.A. The genus Chaganella has been previously recorded only from Kazakhstan. Endemic

Tasmanian forms are Tasmanorthis, Azamella, Teratelasmella, Lepidomena and Maydenella.

MID-CARADOCIAN FAUNAS

Most forms (Dinorthis, Strophomena, Protozøyga, Macrocoelia, Ptychopleurella, Hesperorthis, Skenidioides, Vellamo and Sowerbyella) are pandemic whilst Rhynchotrema, Hallina, Sowerbyites and Holtedahlina are of the American Realm. One form (Tasmanella) is endemic to Tasmania.

MID-ASHGILLIAN FAUNAS

All forms (Dinorthis, Hesperorthis and Ptychopleurella) are pandemic. From the above observations it is obvious that the Tasmanian faunas are much more closely related to Williams' "American Realm" than to his "European Realm". Williams (1973) also admits that owing to the paucity of recent data from Turkey, China, South Asia, East Asia and Australia it is possible that a third realm exists in this region during the Arenig. He, maintains however that evidence from later faunas "does not support this prospect" (p250).

The faunas is these areas are still comparatively poorly known but there are indications of a close association between south and east Asia (particularly Kazakhstan) and Australia. For example, Spanodonta from the Whiterock of Western Australia has recently been recorded from southeast Asia (Liu, 1976). Chaganella has previously only been recorded from the Middle Ordovician of Kazakhstan (Nikitin, 1974). Railtonella from the Whiterock of Tasmania is represented by one species in southwest China (see Chapter 9). A plectambonitacean species from New South Wales has tentatively been referred to Dulankarella (Percival, 1979a), a genus previously recorded only from Kazakhstan. Percival (op. cit.) also records Kassinella from New South Wales, another genus previously recorded only from Kazakhstan. Percival (1979b) has also recorded a further species (left under open nomenclature, "aff Leptellina sp.") which he believes to be congeneric with Leptelloidea multicostata Rukavishnikova (1956) from Kazakhstan.

To determine whether or not a "third realm" exists is beyond the scope of this work but the above generic coincidences lend more support to its possible post-Arenig existence than originally envisaged by Williams (1973).

ENDEMISM OF TASMANIAN ORDOVICIAN ARTICULATE BRACHIOPOD GENERA

Of the forty or more genera of articulate brachiopods recorded herein from the Ordovician sequence of Tasmania, seven genera are new of which six are endemic. These endemic forms are Lepidomena, Teratelasmella, Maydenella, Azamella, Tasmanorthis and Tasmanella. They are restricted to the Middle and Upper

Ordovician of Tasmania, with *Teratelasmella* and *Maydenella* occurring only in the *L. fortimuscula* zone, *Lepidomena* in its two namesake zones (*L. fortimuscula* and *L. pulchra*). *Azamella* and *Tasmanorthis* are found with certainty in three zones (*T. calveri*, *T. costata* and *S.* cf. *oklahomensis* zones) with *Azamella* possibly also occurring in the *L. pulchra* zone. The remaining genus *Tasmanella* is rare and has been found in the *D. westfieldensis* and ?*P. dinorthoides* zones.

CHAPTER EIGHT

THE BRACHIOPOD FAUNA ASSOCIATED WITH A STROMATOPOROID MOUND

INTRODUCTION

Throughout the Cashions Creek Limestone of the Florentine Valley, scattered stromatoporoid colonies occur. It is, however, only in the upper part of the Formation that colonies group together to form mounds. These mounds are usually quite small, only attaining two or three metres in diameter and are widely separated from one another along strike (50 to 100 metres between adjacent mounds).

In the field it was noticed that these mounds seemed to possess a brachiopod fauna of different generic character to that entombed in the surrounding biosparite, so the faunas in and adjacent to one of the mounds were analysed.

The mound selected, located about 200 metres north of Settlement Road, is based on a sharp erosional contact. This surface truncates a sequence of oncosparite and oncobiosparite and is overlain by a coarse to medium grained biosparite surrounding occasional stromatoporoid mounds.

METHOD

The exterior laminae of the stromatoporoids forming the mound, as well as most of the associated fauna were preferentially silicified. This allowed easy extraction of the fauna by etching in acetic acid.

Three samples were collected, they were:-

1. From the middle of the mound, at a height of about 0.3 to 0.5 metres above the base: sample weight approximately 20 kg.

2. From the very coarse biosparite adjacent to the mound: sample weight approximately 10 kg.

3. From the biosparite between 3 and 4 metres south of the mound margin: sample weight approximately 20 kg.

These samples were etched in a 10% v/v acetic acid solution and the insoluble residue gently sieved and washed. The faunal elements were then extracted and counted. The results are reproduced in fig 8.1.

RESULTS

The numerical data presented in fig 8.1 shows the brachiopod fauna from the mound to be much more diverse than that in the adjacent rocks. Forms restricted to

Figure 8.1. Number and type of silicified fossils in the three samples associated with the stromatoporoid mound. Sample one is from the mound itself. Sample two is from the coarse biosparite adjacent to the mound. Sample three is from the biosparite 3 to 4 metres from the mound. In this table:-

DV = disarticulated dorsal valve
VV = disarticulated ventral valve
AR = articulated specimen
MI = minimum number of individuals represented by the sample
d/a = disarticulated
frag = fragments

These latter two abbreviations are associated with an estimate of the number of species represented by the fragments.

SAMPLE No	ONE				TWO				THREE			
FAUNA	DV	VV	AR	MI	DV	VV	AR	MI	DV	VV	AR	MI
Brachiopods												
Bellimurina cf *compressa*	8	10	6	16	-	-	-	-	-	-	-	-
Chaganella sp.	-	-	1	1	-	-	-	-	-	-	-	-
Dactylogonia rara	9	4	5	14	-	-	-	-	-	-	-	-
Hesperorthis longirostroides	1	6	2	8	4	6	-	6	-	-	-	-
Lepidomena fortimuscula	-	1	-	1	7	13	-	13	15	32	1	33
?*Maakina* sp.	-	-	-	-	-	3	1	4	3	2	1	4
Maydenella asymmetrica	50	46	73	123	7	2	-	7	-	-	-	-
Oepikinid indet.	4	3	6	10	1	2	-	2	-	-	-	-
Rhynchotrema bailliei	7	2	11	18	7	6	24	31	1	-	4	5
?*Strophomena* sp.	-	-	-	-	2	-	-	2	-	-	-	-
Teratelasmella plicata	15	33	20	53	1	1	-	1	-	-	-	-

Other fauna	ONE	TWO	THREE
Bivalves	3 d/a	6 d/a,2 species	33 d/a,2 species
Rostroconchs	-	2	3
Gastropods	4 frag	19 frag,2 species	59 frag,5 species
Cephalopods	4 frag,2 species	4 frag	14 frag,2 species
Echinoderms	11 d/a ossicles	200+ d/a ossicles	2 d/a ossicles
Trilobites	2 frag	1 frag	-
Hyolithids	-	-	1

the mound or immediate environs are Bellimurina cf. compressa, Dactylogonia rara, Hesperorthis longirostroides, Maydenella asymmetrica, oepikinid indet. and Teratelasmella plicata. One form, Lepidomena fortimuscula is quite rare on the mound but predominates in the surrounding sediments. ?Maakina sp. has a similar distribution. The rhynchonellide Rhynchotrema bailliei seems largely independent of substrate. Other species namely Chaganella sp. and ?Strophomena sp. occur very rarely. Bivalves, rostroconchs and gastropods are relatively uncommon on the mound but exhibit a greater diversity and occur in greater numbers in the surrounding sediments. Cephalopods are quite rare on, and adjacent to the mound. Further away, however they become more common. Disarticulated echinoderm ossicles are comparatively uncommon on the mound but constitute a considerable proportion of the surrounding coarse biosparite. They are also very rare at a distance from the mound. Trilobites and hyolithids are rare in all samples.

Boucot, Brace and De Mar (1958) in their discrimination of life and death assemblages of brachiopods used three main criteria. These were; the disarticulation ratio; the relative numbers of disarticulated dorsal and ventral valves and the relative sizes of disarticulated dorsal and ventral valves. The first criterion, the disarticulation ratio, is defined as the ratio of remaining articulated shells to orginally articulated shells. The number of originally articulated shells is calculated as the sum of remaining articulated shells and the average of disarticulated dorsal and ventral valves. For a given species this varies with the total distance that the sample of shells moved from their position of life (Boucot, Brace & De Mar _op_. _cit_. p 327-328).

The second criterion is, as stated, simply the ratio between disarticulated dorsal and ventral valves in the sample. This property varies with total distance travelled from life position and with the difference in hydrodynamic properties of the opposing valves. As such it is a measure of the amount of current sorting undergone by the sample.

The final criterion, the relative sizes of disarticulated valves varies in much the same way as the previous feature and is also a measure of the amount of current sorting undergone by the sample.

In Sample 1, perhaps only the two most common species (_M. asymmetrica_ and _T. plicata_) have sample numbers large enough to be of use. In this sample, _M. asymmetrica_ has a disarticulation ratio of 0.60. and a dorsal/ventral ratio for disarticulated speciments of 1.09. These values, associated with the equal and equivalent size distributions of the disarticulated valves indicate that the species has undergone very little if any postmortem transport.

In *T. plicata*, the disarticulation ratio is 0.45 and the dorsal/ventral ratio for disarticulated speciments also 0.45. The ratio of mean length of disarticulated valves is approximately equivalent to that expected from conjunct valves. The high articulation ratio and the equivalence of disarticulated valve sizes would indicate very little post mortem transport. However, the dorsal/ventral ratio (0.45) indicates some sorting has taken place. This is perhaps due to the dorsal valve (moderately convex, with strong fold and high median septum) having a much lower competent velocity than the ventral, valve (weakly convex with strongly developed sulcus). On consensus *T. plicata* probably forms part of the indigenous fauna of the mound.

The other species obtained from sample 1, whilst commonly found articulated, occur in numbers too few to be of use.

Of species found in sample two (adjacent to the mound), *Rhynchotrema bailliei* is the most common and is more often found articulated than otherwise (disarticulation ration = 0.79). Its disarticulated valves are found is approximately equal numbers but these are few and not statistically significant. It seems probable that the *R. bailliei* sample constitutes part of an indigenous population.

Among the few species found in sample three (3 to 4 metres from the mound) *Lepidomena fortimuscula* is the only common one. It is rarely found articulated (disarticulation ratio 0.04) and ventral valves are much more common in the sample than are dorsal valves (ratio = 0.47). The ratio between the mean lengths of the disarticulated valves is, however, equivalent to that expected for originally conjunct valves. From considerations of shape and thickness it would be expected that the dorsal valve (moderately concave and quite thick anteriorly) would have a slightly higher competent velocity than the ventral valve (moderately convex and slightly thickened posteriorly). Despite the occurrence of length equivalent disarticulated valves (a feature possibly explicable by a slight difference in competent velocities) the disparity in numbers of dorsal and ventral valves and the low disarticulation ratio (relative to the other strophomenide in sample 1, *T. plicata*) indicate this sample has undergone some post mortem transport.

MORPHOLOGICAL ADAPTATIONS OF SOME SPECIES

Maydenella asymmetrica

This species usually possesses an asymmetrical commissure. In specimens over 8.0 millimetres in width (2/3 that of largest specimen) the number of dextrally offset commissures approximates the number of sinistral ones. Occasional specimens (about 10% of total) are plicate, though this plication is often somewhat irregular.

Such asymmetry is quite common amoung Mesozoic rhynchonellids inhabiting a perireefal environment (Rozycki, 1948; Ager, 1965, 1967). Ager (1965) thought that "in the special conditions of the reef biome, one inhalant system may have atrophied." Brookfield (1973) in discussing the mode of life of the asymmetric rhynchonellid Torquirhynchia inconstans inferred the asymmetry to be an adaptation to a tidal environment. He believed that "the asymmetric commissure separated the two sides of the lophophore into two independent systems" (p254). The option in which "one side of the animal contained the inhalant current while the other side contained the exhalant current" (p253) meant that either atrophy of half of the lophophore of "specialization of each half of the lophophore for inhalant and exhalant pumping" (p253) would result. The former of these two results was dismissed because no crural atrophy was observed. The latter result, whether non-reversing (as discussed by Brookfield, p254) or reversing (reversal of beat of the lateral cilia has been observed by Atkins (1960) in one recent species) would be a rather inefficient method of feeding, with both halves of the lophophore pumping, but, in essence, only one half collecting food. As the specimens of Maydenella asymmetrica exhibit no atrophy of the dorsal cardinalia or stunting of one side of the shell relative to the other it is thought unlikely that atrophy of half the lophophore occurred. Because of the inherent inefficiency of the "specialization" alternative it seems most likely the feeding system advocated by Brookfield for T. inconstans is applicable to M. asymmetrica.

Teratelasmella plicata

This species is small with extreme development of both a dorsal median septum and median fold. The septum almost completely divides the mantle cavity into two. The species also has a very small pedicle foramen and quite a fragile shell. Such a combination of features would indicate (according to Fürsich & Hurst, 1974) the brachiopod was more suited to a quiet water environment. This is contrary to the interpretation placed on the morphological adaptations of M. asymmetrica. It is thought that T. plicata was adapted to protected recesses in the mound (one articulated specimen was found in such a situation, apparently in life position). In such a protected microenvironment "quiet water" adaptations would perhaps be advantageous.

Rhynchotrema bailliei

This small species, from sampling data, appears to be largely independent of substrate. Because of its small size it was probably able to colonise larger shell fragments or accumulations of smaller fragments, perhaps with a branching pedicle as in Chlidonophora (Rudwick,

1961) or Magadina (Richardson, 1979) or to colonise organic materials (e.g. algae) which usually escape fossilisation.

CONCLUSIONS

The small stromatoporoid mounds in the upper Cashions Creek Limestone were inhabited by a diverse and numerous brachiopod fauna whilst the surrounding soft substrate was inhabited by a brachiopod assemblage of low diversity. The species found in these differing environments were largely mutually exclusive except for one small rhychonellid (R. bailliei) which apparently survived with equal facility in both.

CHAPTER NINE

SYSTEMATIC PALAEONTOLOGY

INTRODUCTION

The first systematic description of Tasmanian Ordovician and earliest Silurian fossils was the work of Etheridge (1883) on a predominantly trilobite fauna from near Railton. Subsequent studies on trilobites are those of Etheridge (1904) and Kobayashi (1940a & b). Corals (including Tetradium) have been dealt with by Hill & Edwards (1941), Hill (1942, 1955), Chapman (1919) and Kenna (1978 unpubl. Hons thesis); cephalopods by Teichert (1947), Teichert and Glenister (1952, 1953) and Stait (1980, 1981 unpubl. Ph.D. thesis); gastropods and algae by Banks and Johnson (1957); bryozoa by Ross (1961); graptolites by Quilty (1971) and Baillie, Banks and Rickards (1978); conodonts by Burrett (1978 unpubl. Ph.D thesis, 1979) and brachiopods by Brown (1948), Laurie (1980) and Sheehan and Baillie (1981).

Faunal lists and reviews of palaeontological data have been given by Johnston (1888), Banks (1957, 1962), Corbett and Banks (1974), Calver (1977 unpubl. Hons thesis) and Page (1978 unpubl. Hons thesis).

SYSTEMATIC METHOD

The terminology used in the Treatise of Invertebrate Palaeontology Part H (1965) has been adopted in the following systematic treatment.

In the subsequent specific descriptions, the specific name and plate reference are followed by an explanation of the specific name (where this name is new). This is followed by a list of the specimens studied, holotype first, paratypes second with supplementary material last. All specimens are deposited in the collection of the Geology Department, University of Tasmania (prefix UTGD). Following this is to be found a brief description of the collecting locality (type or otherwise) with a short geographic description followed by a bracketed reference to the appropriate map in this thesis. Lastly a grid reference is given for the locality, taken from the Tasmanian Lands Department 1 : 100 000 topographic series, with the sheet reference number, its edition number and date of publication.

For each species a brief diagnosis of two to five lines is given before the full description. In this description the first paragraph is concerned with the exteriors of both valves. In this paragraph the dimensions of the largest specimens are given along with the length-width ratios (and variance) of each of the valves. These ratios are based on measurements taken from specimens usually over two thirds maximum size.

The second paragraph of the description is concerned with the ventral interior, whilst the third paragraph describes the dorsal interior.

The description is followed by a table of Statistical data. In this Table:

N = Number of measured specimens

M = Mean of ratio

SD = Standard deviation

V = Variance

L = Maximum length of valve

W = Maximum width of valve

VI = Height of ventral interarea

HW = Hinge width

MFW = Maximum width of muscle field

MFL = Maximum length of muscle field

SPL = Maximum length of spondylium

SPW = Maximum width of spondylium

SYSTEMATIC DESCRIPTIONS

Class ARTICULATA Huxley 1869

Order ORTHIDA Schuchert & Cooper 1932

Suborder ORTHIDINA Schuchert & Cooper 1932

Superfamily ORTHACEA Woodward 1852

Family EOORTHIDAE Walcott 1908

APHEOORTHIS Ulrich & Cooper 1936

Apheoorthis humboldtensis Laurie 1980

See appendix 3 for description and illustrations.

Family HESPERONOMIIDAE Ulrich & Cooper 1936

Remarks. When originally diagnosed, this family was distinguished from the Orthidae by the presence in genera belonging to the former of chilidial plates. Later, Ulrich & Cooper (1938, p.114) refined the diagnosis to include "transverse Orthacea with flattish or shallow valves, orthoid ventral muscles, orthoid brachiophores", a simple cardinal process and a chilidium. They placed the genera *Hesperonomia* Ulrich & Cooper 1936 and *Hesperonomiella* Ulrich & Cooper 1936 in this family.

Later, Williams (1965) distinguished the Hesperonomiidae from the Orthidae on the presence in genera belonging to the former of a subquadrate ventral muscle field extending beyond the umbonal region, variably developed notothyrial ridges and a digitate dorsal mantle canal system. Genera belonging to the latter family had a short, commonly suboval ventral muscle field, no notothyrial ridges and saccate to digitate mantle canal system.

Included in the Hesperonomiidae by Williams (1965) were _Hesperonomia_, _Hesperonomiella_ and _Jivinella_ Havlíček 1949. Havlíček (1977) however placed the genus _Jivinella_ in the Eoorthidae because it had no chilidium. It also possesses a rather well developed pseudospondylium and a dorsal muscle field similar to that of _Apheoorthis_. On this basis, the assignment of _Jivinella_ to the Eoorthidae would appear more reasonable.

HESPERONOMIELLA Ulrich & Cooper 1936

Type species. _Protorthis porcias_ Walcott 1924.

Remarks. In erecting the genera _Hesperonomia_ and _Hesperonomiella_, Ulrich & Cooper (1936) distinguished the latter from the former by its biconvex profile. Williams (1965, p.H309) in essence did not elaborate on this distinction, yet later (Williams, 1974, p.50) he questioned its validity as a feature of generic significance. Williams (1972), in describing _Hesperonomiella_ from Ireland noted "traces of a saccate mantle canal system preserved posterolaterally in the dorsal valve. A saccate dorsal mantle canal system is exhibited very clearly in _Hesperonomiella jurikae_ sp. nov..

The type species of _Hesperonomiella_, _H. porcias_ (Walcott) does not possess a "subquadrate ventral muscle field extending beyond the umbonal region". Indeed, the ventral muscle field of _H. porcias_ is short, subtriangular and is mainly confined to the delthyrial cavity. The same applies to _H. jurikae_ sp. nov.. Other species such as _H. minor_ (Walcott) possess a slightly larger ventral muscle scar.

As noted by Bates (1968, p.143) some of the species assigned to the family Hesperonomiidae by Ulrich & Cooper possess only rudimentary chilidial plates. No chilidial plates were noted by Williams (1977b) in his description of _Hesperonomiella_ sp. from Ireland and none are present in _H. jurikae_ sp. nov.. A revised diagnosis for the genus is presented below.

Diagnosis. Subquadrate in outline, ventribiconvex to planoconvex, multicostellate. Ventral interarea apsacline, delthyrium open. Dorsal interarea low, anacline, notothyrium open or with rudimentary chilidial plates. Ventral muscle field subtriangular to quadrate, in some species restricted to the delthyrial cavity, with adductors and diductors about equal in length. Ventral mantle canal system saccate with vascula media diverging anteriorly. Brachiophores rod-like, unsupported. Cardinal process strong, ridge-like. Dorsal mantle canal system saccate.

Hesperonomiella jurikae sp. nov.
Plate 1, figs 1-19

Name. After R.M. Jurik who collected some of the type lot of specimens.

Material. Holotype UTGD 120288; Paratypes UTGD 120256, 120256, 120260, 120262, 120272, 120273, 120286a & b, 120289a & b, 120290, 120259; Other material UTGD 120257, 120259, 120261, 120263-71, 120274-85, 120287-8, 120291.

Type locality. In bed of small costean 150 m north of Caroline Quarry Road just over 0.5 km from turnoff (point A in fig 3.2, road not marked on any existing topographic maps).

Diagnosis. Subquadrate to transversely ovate Hesperonomiella with high ventral interarea and short triangular ventral muscle field.

Description. Shell up to 14.9 mm wide and 12.2 mm long. Mean length-width ratio of ventral valve 0.79 (variance 0.0029); dorsal valve 0.82 (variance 0.0019). Shell ventribiconvex, subquadrate to transversely ovate with maximum width between hingeline and midlength. Hinge width approximately nine tenths maximum width. Ventral valve moderately and evenly convex with flattened lateral slopes. Dorsal valve moderately and evenly convex with weak sulcation best developed posteriorly. External ornament evenly multicostellate with from 21 to 26 costellae (mode 23) within 5 mm at a distance of 5 mm from beak. Ventral interarea approximately one fifth as high as wide, planar, apsacline. Delthyrium open. Dorsal interarea approximately one eighth as high as wide, planar, anacline. Notothyrium open.

Teeth strong, boss-like, supported by very short stout divergent dental plates. Muscle field triangular, approximately nine tenths as wide as long, extending anteriorly approximately one third of valve length. Diductors subtriangular, extending beyond but not enclosing broad triangular median adductor scar. Ventral mantle canal system saccate, vascula media broad, proximally adjacent and slightly divergent anteriorly, distal portions curving laterally to enclose subcircular gonadal sacs. Follicular embayments short, deep and narrow.

Brachiophores short, lenticular in section, bounding deep narrow notothyrial cavity. Notothyrial platform short triangular, occupied by well developed narrow ridgelike cardinal process. Low, rounded median ridge arises from anterior margin of notothyrial platform and extends to or nearly to valve midlength. Posterior adductors small, subtriangular to ovate with long axes directed anterolaterally. Anterior adductors twice the area of posterior scars, subtriangular, with long axes diverging anteriorly. Anterior scars separated from posterior scars by narrow, poorly developed, slightly oblique ridges. Dorsal mantle canal system saccate with vascula media diverging slightly anteriorly, vascula myaria curving posterolaterally.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	5	0.79	0.05	0.0029
VI/HW	4	0.21	0.02	0.0003
MFW/MFL	4	1.93	0.13	0.0178
MFL/L	4	0.34	0.04	0.0019
HW/W	11	0.89	0.05	0.0025
		Dorsal Valve		
L/W	6	0.82	0.04	0.0019

Remarks. This species is perhaps most similar to H. minor (Walcott) but differs in having a shorter ventral muscle field restricted to the delthyrial cavity and in having a higher ventral interarea.

Family ORTHIDAE Woodward 1852

Subfamily ORTHINAE Woodward 1852

ARCHAEORTHIS Schuchert & Cooper 1931

Archaeorthis subcarinata Laurie 1980

See appendix 3 for description and illustrations.

NANORTHIS Ulrich & Cooper 1936

Nanorthis carinata Laurie 1980

See appendix 3 for description and illustrations.

Family DOLERORTHIDAE Öpik 1934

Subfamily HESPERORTHINAE Schuchert & Cooper 1931

HESPERORTHIS Schuchert & Cooper 1931

Type species. *Orthis tricenaria* Conrad 1843.

Hesperorthis longirostroides sp. nov.

Plate 2, figs 4-46; Plate 3, figs 1-35; Plate 4, figs 1-8.

Name. This species resembles *H. longirostris* Cooper 1956.

Material. Holotype UTGD 120733; Paratypes UTGD 120735, 120738, 120740, 120741, 120742, 120743, 120744, 120754, 120755, 120762, 120763, 120764, 120765; Other material UTGD 120732, 120734, 120736-7, 120739, 120745-53, 120756-61, 120766-73.

Type locality. Ugbrook Member of Chudleigh Limestone on north side of Standard Hill, on spur immediately above road, at closest approach of Sassafras Creek. Locality 94 on fig 4.3.

Diagnosis. A medium sized subquadrate to semi-ovate _Hesperorthis_ with a very high apsacline (nearly catacline) ventral interarea and 19 to 27 costae.

Description. Shell up to 15.5 mm wide and 12.8 mm long. Mean length-width ratio (for specimens of width greater than 10.0 mm) of ventral valve, 0.85 (variance 0.0019); dorsal valve, 0.76 (variance 0.0035). Shell strongly ventribiconvex, subquadrate or semi-ovate with maximum width at hingeline or at midlength. Cardinal extremities angular, varying from slightly obtuse to right angled, or with small acute ears. Ventral valve hemipyramidal with maximum convexity in posterior half. In posterior view, lateral slopes flattened, midportion narrowly arched. Dorsal valve weakly convex, with maximum convexity in anterior half, posterior half planar. Weak sulcus commonly developed. External ornament costate with between 19 and 27 (mode 20-24) costae. Interstices occupied by two, three or four much finer parvicostellae. Ventral interarea about one third as high as wide, slightly concave, apsacline (nearly catacline). Apical plate occupying one tenth to one fifth height of delthyrium.

In some well preserved larger specimens it appears that the apical plate and a portion of the beak have been resorbed. Dorsal interarea about one third as high as ventral, planar, anacline, notothyrium open or with rudimentary antygidium.

Teeth triangular, plate-like, supported by very short divergent dental plates. Muscle field cordate, approximately three quarters as wide as long, extending anteriorly about four-tenths valve length. Diductors tear-shaped, extending beyond but not enclosing narrow linear adductor scars. Vascula media indistinct, proximally subparallel or slightly anteriorly divergent. Vascula genitalia sac-like, obliquely striate. Follicular embayments prominent, extending posteriorly up to one third valve length in larger specimens.

Brachiophores long, pointed distally, bounding narrow, semiconical sockets. Notothyrial cavity deep. Notothyrial platform transversely concave, rhombic, occupied by narrow bladelike cardinal process. Median ridge broad, rounded, usually extending beyond valve mid-length. Posterior adductor longitudinally ovate, located anterior to brachiophores adjacent to median ridge. Anterior adductors broadly triangular with apices directed posteromedially such that proximal sections of vascula myaria diverge anteriorly from one another at an angle of about 130 degrees. Vascula genitalia subcircular, obliquely striate. Follicular embayments prominent, extending posteriorly up to one third valve length in larger specimens.

Statistics (for specimens greater than 10 mm wide).

	N	M	SD	V
		Ventral Valve		
L/W	8	0.85	0.04	0.0019
VI/HW	15	0.32	0.03	0.0010
MFW/MFL	7	0.76	0.09	0.0086
MFL/L	7	0.42	0.04	0.0018
		Dorsal Valve		
L/W	18	0.76	0.06	0.0035
MFW/MFL	9	0.70	0.05	0.0026
MFL/L	9	0.73	0.02	0.0006

Remarks. In general shape *H. longirostroides* most closely resembles *H. longirostris* Cooper 1956 but differs from the later in possessing fewer costae and commonly auriculate cardinal extremities.

Hesperorthis benjaminensis sp. nov.

Plate 1, figs 20-30; Plate 2 figs 1-3.

Name. This species is found in the Benjamin limestone in the Florentine Valley.

Material. Holotype UTDG 99150; Paratypes UTGD 99158, 99151, 99152, 99153, 99154, 99155, 99156, 99157, 99158.

Type locality. Lower Limestone Member of Benjamin Limestone, 100m southeast of Sixteen Road, Florentine Valley (Locality 4 on section E, fig 2.9) GR 561855, sheet 8112 Edition 4, 1979.

Diagnosis. A medium sized sub-pentagonal to sub-circular *Hesperorthis* with a very high apsacline ventral interarea and 22 to 28 costae, half of which arise by intercalation less than 3.0 mm from beak.

Description. Shell up to 19.4 mm wide and 16.0 mm long. Mean length-width ratio of ventral valve 0.80 (variance 0.0140) length-width ratio of single dorsal valve estimated at 0.64. Shell strongly ventribiconvex, subpentagonal to subcircular, with maximum width at or slightly anterior to hinge. Ventral valve moderately convex with greatest convexity in posterior half, lateral slopes flattened. Dorsal valve weakly convex with sulcus distinct posteriorly, broadening and almost disappearing anteriorly. External ornament costate with between 22 and 28 costae, between 11 and 13 of which arise at protegulum margin, remainder arise by intercalation at a distance of 0.5 to 3.0 mm from beak. Ventral interarea about one third as high as wide, planar or very slightly concave, apsacline, apex of delthyrium occupied by apical plate. Dorsal interarea one third as high as ventral, planar, anacline. Apex of notothyrium occupied by short antygidium.

Teeth small, triangular in section, supported by short divergent dental plates. Muscle field pentagonal, slightly longer than wide in larger specimens, extending anteriorly about one third valve length. Diductors triangular, extending slightly beyond but not enclosing narrow, linear adductors. Vascula media parallel till just beyond valve midlength, then diverging sharply. Follicular embayments prominent, extending posteriorly up to one fifth valve length.

Brachiophores moderately long, narrowly blade-like, pointed distally, bounding narrow semiconical sockets. Notothyrial cavity deep. Notothyrial platform transversely concave, rhombic, occupied by high, anteriorly thickened cardinal process. Median ridge broad, rounded, extending beyond midlength. Posterior adductors ovate, elongate with long axes directed anterolaterally, located immediately anterior to brachiophores, adjacent to median ridge. Anterior adductors rhombic, long axes directed anterolaterally such that proximal sections of vascula myaria diverge anteriorly from one another at an angle of about 120 degrees. Follicular embayments prominent, extending posteriorly up to one quarter of valve length in larger specimens.

Statistics.

Ventral Valve

	N	M	SD	V
L/W	5	0.80	0.12	0.0140
VI/HW	6	0.34	0.04	0.0014
MFW/MFL	5	0.95	0.02	0.0005
MFL/L	5	0.35	0.05	0.0021

Remarks. This species, in shape and ornamentation most closely resembles *H. matutina* Cooper 1956. It differs externally however in having a much higher ventral interarea. Internally *H. benjaminensis* differs in having a shorter ventral muscle field and much longer brachiophores. This species differs from *H. longirostroides* in having an external ornament in which the number of costae increases by intercalation, in never possessing auriculate cardinal extremities and in having a ventral interarea at a much lower angle to the commissural plane.

Subfamily GLYPTORTHINAE Schuchert & Cooper 1931

PTYCHOPLEURELLA Schuchert & Cooper 1931

Type species. *Orthis bouchardi* Davidson 1847.

Ptychopleurella magna sp. nov.

Plate 4, figs 9-24.

Name. This species is large for *Ptychopleurella*.

Material. Holotype UTGD 97187; Paratypes UTGD 98186, 97188, 99391, 99396, 99413, 99416, 99432; Other material UTGD 99392, 99394-5, 99397-412, 99414-5, 99433,40.

Type locality. Lower Limestone Member of Benjamin Limestone, Westfield Road Section (locality H in fig 2.11), Florentine Valley. G.R. 561857 sheet 8112, edition 4, 1979.

Diagnosis. Large subquadrate to subpentagonal ventribiconvex coarsely costellate *Ptychopleurella* with dorsal and ventral sulci, apsacline ventral interarea and orthocline dorsal interarea.

Description. Shell up to 16.4 mm wide and 15.1 mm long. Mean length-width ratio of ventral valve 0.80 (variance

0.0056), dorsal valve 0.70 (variance 0.0019). Shell ventribiconvex, subquadrate to subpentagonal with maximum width at about midlength. Hinge width approximately nine tenths maximum width. Ventral valve moderately to strongly convex, with maximum convexity usually in posterior half. Lateral slopes rarely flattened. Ventral sulcus broad, shallow, only developed anteriorly, giving anterior margin of shell a slight indentation. Dorsal valve moderately to strongly convex, convexity even. Lateral slopes usually flattened. Sulcus well developed, v-shaped. External ornament coarsely costellate with from 5 to 9 (mode 7) costellae occurring within 5 mm at a distance of 5 mm from beak. Costellae increase in number by bifurcation concentric imbrication not well preserved. Ventral interarea approximately one third as high as wide, planar or slightly concave, apsacline. Delthyrium broad, occasionally with small arcuate pedicle callist occupying apex. Dorsal interarea low, moderately concave, orthocline. Notothyrium open.

Teeth strong, triangular in section, supported by very short, thin dental plates. Muscle field almost nine tenths as wide as long, extending anteriorly almost one half valve length. Diductors subtriangular, not extending as far anteriorly as broad triangular median adductors. Vascula media short, slightly divergent. Follicular embayments very narrow, lightly impressed, extending posteriorly less than one fifth of valve length in larger specimens.

Brachiophores short, distally rectangular in section, bounding semi-conical sockets. Notothyrial cavity deep. Notothyrial platform triangular, occupied by high blade-like cardinal process. Posterior adductors transversely ovate, located directly beneath brachiophores. Anterior adductors slightly larger than posterior scars, ovate, elongated anterolaterally such that proximal portions of vascula myaria diverge anteriorly from one another at approximately 100 degrees. Proximally, vascula media diverge slightly anteriorly. Follicular embayments vary narrow, lightly impressed, extending posteriorly less than one fifth valve length.

Statistics.

Ventral Valve

	N	M	SD	V
L/W	20	0.80	0.08	0.0056
VI/HW	20	0.31	0.05	0.0021
MFW/MFL	18	0.86	0.15	0.0226
MFL/L	18	0.42	0.05	0.0029
HW/W	20	0.89	0.06	0.0036

Dorsal Valve

	N	M	SD	V
L/W	14	0.70	0.04	0.0019

Remarks. This species is distinguished from most others of the genus by its comparatively fine costellate ornament, its long distinctly apsacline ventral interarea and its much larger size.

Ptychopleurella cf. magna.
Plate 4, figs 25-37.

Material. UTGD 99441-99465.

Locality. Same as for Hesperorthis benjaminensis sp. nov.

Diagnosis. Differs from P. magna in having a less well developed dorsal sulcus and in being little more than half the size of the latter.

Description. Shell up to 10.0 mm wide and 8.3 mm long. Mean length-width ratio of ventral valve 0.80 (variance 0.0042). Shell ventribiconvex, subpentagonal with maximum width at about midlength. Hinge width about nine tenths maximum width. Ventral sulcus poorly developed. Dorsal sulcus distinct. External ornament coarsely costellate with between 16 and 20 (mode 17) costellae occurring. Concentric imbrication produced as frills. Ventral interarea about one third as high as wide, planar to slightly concave, apsacline. Dorsal interarea low anacline to orthocline.

Interiors similar to P. magna sp. nov.

Statistics.

Ventral Valve

	N	M	SD	V
L/W	9	0.80	0.07	0.0042
VI/HW	10	0.32	0.04	0.0015
MFW/MFL	8	0.86	0.16	0.0260
MFL/L	6	0.41	0.03	0.0011
HW/W	10	0.87	0.05	0.0025

Remarks. The only major difference between this group of specimens and those assigned to Ptychopleurella magna is one of size. P. cf magna only ever reaches a little over half the size of P. magna. As the exact relationship between the two groups of specimens is unknown, the specimens described above are only tentatively referred to P. magna.

Family PLAESIOMYIDAE Schuchert 1913

Subfamily PLAESIOMYINAE Schuchert 1913

DINORTHIS Hall & Clarke 1892

Type species. Orthis pectinella Conrad & Emmons 1842.

Dinorthis westfieldensis sp. nov.

Plate 5, figs 1-15.

Name. The type locality for this species is near Westfield Quarry.

Material. Holotype UTGD 99061; Paratypes UTGD 99045, 99047, 99053, 99065, 99067, 99069, 99070, 99072, 99086, 99088; Other material UTGD 99044, 99046, 99048-52, 99054-60, 99062-66, 99068, 99071, 99073-85, 99087, 99089-90.

Type locality. Lower Limestone Member, Benjamin Limestone, Westfield section Florentine Valley (Locality K in fig 2.11). G.R. 593 793 sheet 8212, Edition 1, 1976.

Diagnosis. Medium sized *Dinorthis* with narrow hingeline, high, nearly catacline ventral interarea, strongly convex dorsal valve and short quadrate ventral muscle field.

Description. Shell up to 20.8 mm wide and 15.4 mm long. Mean length-width ratio of ventral valve 0.80 (variance 0.0021), dorsal valve 0.80 (variance 0.0020). Shell dorsibiconvex, transversely ovate with maximum width at midlength. Hinge width approximately three quarters maximum width. Ventral valve moderately convex with greatest convexity in posterior half, slightly flattened lateral slopes, anteromedial portion of valve flattened. Dorsal valve moderately to strongly convex, usually with greatest convexity in posterior half, flattened lateral slopes. External ornament costate with between 20 and 28 (mode 25) costae. Bifurcation or intercalation rare. Ventral interarea one fifth as high as wide, slightly concave, apsacline (nearly catacline). Delthyrium with small arcuate pedicle callist. Dorsal interarea low, moderately concave, orthocline, notothyrium open.

Teeth strong, ovate or triangular in section, supported by short, stout, dental plates. Muscle field quadrate, about three quarters as wide as long, extending anteriorly slightly less than one half valve length. Diductors subtriangular, extending beyond and enclosing centrally located, narrow, ovate adductors. Adjustors prominent, narrowly triangular, extending anteriorly over three quarters muscle field length. Vascula media, short, divergent. Follicular embayments prominent, sometimes extending posteriorly up to one quarter of valve length in larger specimens.

Brachiophores, heavy, thick, bounding semi-conical to semi-ellipsoidal sockets. Notothyrial cavity deep, platform very short, occupied by large cardinal process with thick erect shaft and triangular, posteriorly crenulate myophore. Myophore medially cleft in larger specimens.

Median ridge broad, low, short. Posterior adductors triangular, directly anterior to brachiophores, sometimes possessing 2 or 3 narrow oblique ridges. Anterior adductors ovate, indistinct. Follicular embayments prominent, extending posteriorly up to one third of valve length in larger specimens.

Statistics.

Ventral Valve

	N	M	SD	V
L/W	17	0.80	0.05	0.0021
VI/HW	20	0.21	0.03	0.0008
MFW/MFL	20	0.78	0.07	0.0044
MFL/L	17	0.45	0.03	0.0010
HW/W	35	0.73	0.05	0.0022

Dorsal Valve

	N	M	SD	V
L/W	15	0.80	0.04	0.0020

Remarks. In general shape, costation, and details of the ventral interior, this species is most similar to D. pectinella (Conrad & Emmons 1842) but differs in that it is much thicker, has a higher ventral interarea and a well developed anterior flattening of the ventral valve.

Dinorthis holdenoides sp. nov.

Plate 5, figs 16-30; Plate 6, figs 1-11.

Name. This species is similar in appearance to *D. holdeni* (Willard).

Material. Holotype UTGD 99091; Paratypes UTGD 99092, 99093, 99096, 99097, 99104, 99105, 99106, 99107, 99108, 99111, 99116; Other material UTGD 99094-5, 99098-103, 99109-10, 99112-5.

Type locality. Upper Limestone Member, Benjamin Limestone, Westfield Section, Florentine Valley (Locality S in fig 2.11) G.R. 588791 Sheet 8112, Edition 4, 1979.

Diagnosis. Medium sized *Dinorthis* with wide hingeline, moderately high catacline ventral interarea, a strongly convex, sulcate, dorsal valve and a large, bilobate, ventral muscle field.

Description. Shell up to 23.8 mm wide and 19.5 mm long. Mean length-width ratio for ventral valve 0.72 (variance 0.0015), dorsal valve 0.77 (variance 0.0016). Shell dorsibiconvex to convexiplanar, transversely subquadrate to semicircular with maximum width at, or slightly posterior to midlength. Hinge width over three quarters maximum width. Ventral valve moderately convex in posterior half, anterior half planar, lateral slopes slightly concave. Dorsal valve evenly and strongly convex, lateral slopes slightly convex, dorsal sulcus distinct in larger specimens, containing 3 or 4 costae. External ornament costate with between 26 and 34 (mode 28) costae. Bifurcation or intercalation very rare, only observed near lateral margins. Ventral interarea about one sixth as high as wide, slightly concave, catacline. Delthyrium with small arcuate pedicle callist. Dorsal interarea low, moderately concave, orthocline or apsacline, notothyrium open.

Teeth strong, triangular in section, supported by short, widely divergent dental plates. Muscle field large bilobed, slightly narrower than long, extending anteriorly about one half valve length. Diductors triangular, extending beyond and enclosing anteriorly located, narrowly ovate adductors. Adjustors usually prominent, extending anteriorly about three quarters muscle field length. Mantle canal system not preserved. Follicular embayments prominent, in larger specimens extending posteriorly up to one quarter valve length.

Brachiophores, strong, thick, bounding semi-conical sockets. Notothyrial cavity deep, platform very short, occupied by high cardinal process with narrow erect shaft and narrowly triangular, posteriorly crenulate myophore.

Median ridge broad, low, rarely extending anteriorly to one third valve length. Adductor scars not preserved. Fillicular embayments prominent, extending posteriorly up to one half valve length in larger specimens.

Statistics.

Ventral Valve

	N	M	SD	V
L/W	8	0.72	0.04	0.0015
VI/HW	10	0.15	0.02	0.0005
MFW/MFL	11	0.91	0.06	0.0040
MFL/L	8	0.49	0.02	0.0006
HW/W	22	0.80	0.06	0.0036

Dorsal Valve

	N	M	SD	V
L/W	13	0.77	0.04	0.0016
DI/HW	12	0.08	0.02	0.0003

Remarks. This species is very similar to *D. holdeni* (Willard) and *D. kassini* Rukavishnikova in general appearance. *D. holdeni* differs in having a much less convex dorsal valve and an anteriorly concave ventral valve, and in being less transverse than *D. holdenoides* sp. nov.. *D. kassini* differs in having a relatively longer hingeline, a tendency for the anterior portion of the ventral valve to be concave and a much smaller ventral muscle field.

Superfamily PLECTORTHACEA Schuchert & LeVene 1929
(nom transl., Havlíček 1977, ex Plectorthinae Schuchert & LeVene, 1929).
Family PLECTORTHIDAE Schuchert & LeVene 1929
Subfamily PLECTORTHINAE Schuchert & LeVene 1929
PLECTORTHIS Hall & Clarke 1892.

Type species. *Orthis plicatella* Hall 1847.

Remarks. Schuchert and Cooper (1932) in their detailed diagnosis of *Plectorthis* stated that the ventral muscle scar was "heart shaped, occupying between one third and one half the length of the shell; adductor track linear, confined within the diductor scars; diductors subcrescentic". The illustration given for *Plectorthis plicatella* (Hall) (Schuchert & Cooper 1932, plate 11, fig 9) shows a fairly broad adductor scar (about one third to one quarter muscle field width) which does not appear to be surrounded by the diductors, though the illustration is not clear enough for this to be ascertained. The illustration of *Plectorthis jamesi* (Hall) (Schuchert & Cooper, 1932, plate 11, fig 2) shows a broad adductor scar not surrounded by the diductors.

Williams (1965, p. H324) diagnosed *Plectorthis* as having a cordate ventral muscle scar "with subcrescentic diductor scars enclosing linear adductor track". The illustration (fig 204-6d) that accompanies this diagnosis is not of the type species but of Plectorthis ponderosa Cooper, a species which possesses divergent diductor divided by a triangular adductor scar.

A similar arrangement of the ventral muscle field is also present in P. tenuis Cooper 1956, ?P. obesa Cooper (Ross 1970) P. cf. perplexus (Ross) (Ross, 1970) and ?Plectorthis sp. (Ross, 1970). Ross (op. cit. p 58) noted that the ventral muscle fields of ?P. obesa Cooper and P. ponderosa Cooper are very similar to that of Austinella Foerste. He also noted that the 'discrete fulcral plates" characteristic of Plectorthis are not developed in ?P. obesa and considers it possible that this latter species is better assigned to Austinella. In the only published illustration of the dorsal valve of P. ponderosa Cooper (Cooper 1956a, plate 83 fig 29; Williams & Wright (1965) use same photograph) fulcral plates are not evident and it is possible that P. ponderosa may also be assignable to Austinella.

If Plectorthis plicatella (Hall) does have a broad median adductor not encircled by the diductors, as indicated by the illustration of Schuchert & Cooper (1932) it is possible that Austinella Foerste is a synonym of Plectorthis Hall & Clarke. If P. plicatella does have confined adductors, as diagnosed by Schuchert & Cooper

(1932) then such species as ?*P. obesa* Cooper (Ross, 1970) *P. ponderosa* Cooper, and possibly *P. jamesi* (Hall) and *P. tenuis* Cooper would be better assigned to *Austinella*.

Because of this confusion over the nature of *Plectorthis* the species described below is only tentatively referred to the genus.

?*Plectorthis dinorthoides* sp. nov.

Plate 6, figs 12-37; Plate 7, figs 1-9.

Name. The general form of this species is reminiscent of *Dinorthis*.

Material. Holotype UTGD 99190; Paratypes UTGD 99159, 99163, 99164, 99165, 99167, 99168, 99170, 99171, 99172, 99176, 99179, 99181, 99182, 99191, 99193, 99195, 99197, 99198, 99199, 99200, 99201; Other material UTGD 99160-2, 99166, 99169, 99173-5, 99177-8, 99180, 99183-9, 99192, 99194, 99196, 99201-19.

Type locality. Upper Limestone Member of Benjamin Limestone, Westfield Section, Florentine Valley (locality RA in fig 2.11) G.R. 588791 Sheet 8112, Edition 4, 1979.

Diagnosis. Medium sized, transversely ovate ventribiconvex *Plectorthis* with high ventral interarea, broad, very shallow ventral sulcus.

Description. Largest specimen is a dorsal valve 17.6 mm wide and 12.7 mm long. Mean length-width ratio for ventral valve 0.76 (variance 0.0054), for dorsal valve 0.71 (variance 0.0029). Shell slightly ventribiconvex, transversely ovate, with maximum width at about midlength. Hinge width about four fifths valve width. Ventral valve moderately convex with maximum convexity in posterior half, lateral slopes flattened. Sulcus broad, very shallow, only evident anteriorly. Dorsal valve moderately convex, sometimes with maximum convexity in posterior half, otherwise evenly convex. Lateral slopes slightly flattened, fold broad, very poorly developed. External ornament costate with between 26 and 33 (mode 31) costae on valves over 7 mm long. Bifurcation not observed, intercalation uncommon. Ventral interarea slightly more than one quarter as high as wide, slightly to moderately concave, apsacline (nearly catacline). Delthyrium sometimes with small arcuate pedicle callist. Dorsal interarea one tenth as high as wide, planar or slightly concave, anacline, notothyrium open.

Teeth strong, triangular in section, supported by short, thick, dental plates. Muscle field laterally bounded by low ridge-like extensions of dental plates, cordate, nearly nine tenths as wide as long (for valves over 7 mm long), extending anteriorly about two fifths valve length. Diductors semi-ovate, extending slightly beyond but not enclosing lanceolate adductors. Mantle canal system not preserved. Follicular embayments prominent, extending posteriorly up to one half valve length in larger specimens.

Brachiophores short, bladelike, distally rectangular. Bases receding, converging on to short low median ridge, laterally bounding deep notothyrial cavity. Cardinal process with thin shaft and narrow posteriorly crenulate myophore. Sockets deep, semi-conical, underlain by well developed fulcral plates. Muscle field and mantle canal system not preserved. Follicular embayments prominent extending posteriorly up to one half of valve length from anterior margin in larger specimens.

Statistics.

Ventral Valve

	N	M	SD	V
L/W	20	0.76	0.07	0.0054
VI/HW	23	0.28	0.03	0.0011
MFW/MFL	9	0.86	0.08	0.0061
MFL/L	9	0.39	0.03	0.0008
HW/W	42	0.82	0.06	0.0031

Remarks. In general shape and style of costation this species is perhaps most similar to P. pennsylvanica Cooper 1956 and P. symmetrica Cooper 1956 but differs from both of these species in being larger, in having a broad ventral sulcus, in having the maximum convexity of the ventral valve in the posterior half, and in having a considerably higher ventral interarea.

Subfamily TASMANORTHINAE subfam nov.

Diagnosis. Costate with well developed interareas, brachiophore bases divergent onto floor of valve, fulcral plates small, cardinal process with short shaft and medially cleft crenulate myophore.

Remarks. This subfamily of the Plectorthidae is erected to include the genus Tasmanorthis nov.. The dorsal cardinalia of species belonging to this genus are similar to some members of the Draboviinae, however, sectioning of some unsilicified fragments probably referable to this genus revealed an impunctate shell.

TASMANORTHIS gen. nov.

Name. A Plectorthid genus apparently endemic to Tasmania.

Type species. Tasmanorthis costata sp. nov.

Diagnosis. Subquadrate, subequally biconvex, coarsely costate, costae pustulose, interspaces with fine radial lirae. Ventral interarea apsacline or catacline, delthyrium open. Dorsal interarea short, anacline, notothyrium open. Ventral muscle field short, subquadrate. Median adductor scar subtriangular, diductors subrhombic to subtriangular. Dentral plates short, thick, divergent. Brachiophore bases divergent. Cardinal process with short shaft and medially cleft crenulate myophore.

Remarks. This genus differs from those assigned to the Plectorthinae, Platystrophiinae and Cyclocoelinae in possessing distinctly divergent brachiophore bases. It differs from _Rhactorthis_ in possessing discrete fulcral plates rather than having its sockets defined by the divergent brachiophore bases.

Tasmanorthis costata sp. nov.
Plate 7, figs 10-40.

Name. Alluding to the external ornament.

Material. Holotype UTGD 99235; Paratypes UTGD 99223, 99226, 99236, 99239, 99240, 99241, 99242, 99245, 99249, 99268, 99270, 99335; Other material UTGD 99221-2, 99224-5, 99227-35, 99237-8, 9924304, 99246-8, 99250-67, 99269, 99336-40.

Type locality. Lower Limestone Member, Benjamin Limestone, Westfield Section, Florentine Valley (Locality F in fig 2.11) G.R. 593798, Sheet 8212, Edition 1, 1976.

Diagnosis. *Tasmanorthis* with from 16 to 23 (mode 20) costae and with narrow median ridge separating ventral adductors.

Description. Shell up to 14.7 mm wide and 12.5 mm long. Mean length-width ratio of ventral valve 0.73 (variance 0.0008), dorsal valve 0.72 (variance 0.0023). Shell subequally biconvex, subquadrate, with maximum width at about midlength. Hinge width approximately four fifths maximum width. Ventral valve slightly and evenly convex in lateral and anterior views. External ornament costate with between 16 and 23 (mode 20) costae on valves over 5.0 mm long. Costation tending toward rectangular in cross section. Bifurcation very rare. Ventral interarea about one fifth as high as wide, planar, apsacline or catacline. Delthyrium open. Dorsal interarea approximately half as high as ventral, slightly concave, anacline. Notothyrium open.

Teeth large, triangular or ovate in section, supported by very short, thin, strongly divergent dental plates. Muscle field quadrate, approximately four fifths as long as wide, extending anteriorly about one third valve length. Diductors subtriangular, extending slightly beyond but not enclosing broad, triangular median adductor scar. Adductor scars separated from each other by low narrow median ridge which rarely extends beyond muscle field. Vascula media proximally divergent, rarely preserved. Follicular embayments prominent, may extend posteriorly up to two thirds valve length in larger specimens.

Brachiophores, short, bladelike. Bases well developed, parallel or slightly curved laterally. Sockets semi-conical to semi-ellipsoidal, underlain by variably developed fulcral plates. Notothyrial cavity deep, platform very indistinct, subtriangular, occupied by small cardinal process with thin sessile shaft occurring as ridge bisecting notothyrial platform, occasionally extending slightly anterior of platform. Posterior adductors large, subquadrate, rarely impressed, located immediately anterior to lateral sectors of notothyrial platform. Anterior adductors about one half to two thirds area of posterior scars, transversely, ovate, located immediately anterior to posterior scars such that proximal portions of vascula myaria are directed laterally. Follicular embayments prominent, extending posteriorly up to one half valve length in larger specimens.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	17	0.73	0.03	0.0008
VI/HW	18	0.22	0.02	0.0005
MFL/MFW	19	0.81	0.10	0.0090
MFL/L	17	0.31	0.03	0.0009
HW/W	50	0.82	0.05	0.0026
		Dorsal Valve		
L/W	30	0.72	0.05	0.0023
DI/HW	32	0.10	0.01	0.0002

Tasmanorthis calveri sp. nov.

Plate 7, figs 41-62; Plate 8, figs 1-24.

Name. After Mr C. Calver.

Material. Holotype UTGD 99390; Paratypes UTGD 99341, 99342, 99343, 99344, 99346, 99349, 99351, 99357, 99358, 99359, 99361, 99362, 99375, 99377, 99378, 99380, 99381, 99382, 99385, 99386, 99388; Other material UTGD 99345, 99347-8, 99350, 99352-6, 99360, 99363074, 99376, 99379, 99383-4, 99387, 99389.

Type locality. Lower Limestone Member, Benjamin Limestone, Settlement Road Section, Florentine Valley (Locality 9 on section marked B, fig 2.9). G.R. 566 864, sheet 8112, Edition 4, 1979.

Diagnosis. *Tasmanorthis* with from 14 to 19 (mode 17) costae and with interspaces broader than costae. Ventral muscle field with median adductor scar slightly raised on linear platform.

Description. Shell up to 13.1 mm wide and 10.4 mm long. Mean length-width ratio of ventral valve 0.73 (variance 0.0018), dorsal valve 0.75 (variance 0.0028). Shell subequally biconvex, subquadrate with maximum width at about midlength. Hinge width approximately four fifths maximum width. Ventral valve slightly and evenly convex, becoming dorsally geniculate in gerontic specimens. Lateral slopes strongly flattened. Dorsal valve evenly convex in anterior and lateral views, some larger specimens with maximum convexity near anterior margins. External ornament costate with between 14 and 19 (mode 17) costae on valves over 5 mm long. At anterior margin of larger specimens costation tends towards sinusoidal cross-section. Bifurcation rare. Ventral interarea about one quarter as high as wide, planar, apsacline or catacline. Delthyrium open. Dorsal interarea approximately half as high as ventral, planar, anacline. Notothyrium open.

Teeth large, triangular in section, supported by very short thick dental plates. Muscle field quadrate, approximately as long as wide, though variable; extending anteriorly about one third valve length. Diductors subrhombic, extending slightly beyond but not enclosing broad, rectangular, slightly raised, median adductor scar. Vascula media short, divergent. Follicular embayments prominent, in some larger specimens extending posteriorly as much as one half valve length.

Brachiophores short, bladelike. Bases receding, thin, parallel or slightly curved laterally. Sockets semiconical, underlain by variably developed fulcral plates. Notothyrial cavity deep, platform indistinct, longitudinally ovate, occupied by strong cardinal process with sessile shaft and triangular, crenulate myophore. Myophore always medially cleft, furrow occasionally extending entire length of shaft. Posterior adductors large, subquadrate, faintly impressed, located immediately anterior to notothyrial platform, scars sometimes separated from one another by short, low, narrow median ridge. Anterior adductors about one half area of posterior scars, ovate, elongated posterolaterally, sometimes raised anteriorly, located immediately anterior to posterior scars. Follicular embayments prominent, extending posteriorly over one half valve length in larger specimens.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	16	0.73	0.04	0.0018
VI/HW	13	0.23	0.02	0.0005
MFL/MFW	14	0.96	0.19	0.0370
MFL/L	14	0.32	0.03	0.0010
HW/W	41	0.79	0.07	0.0053
		Dorsal Valve		
L/W	26	0.75	0.05	0.0028
DI/HW	26	0.12	0.02	0.0002

Remarks. This species differs from *T. costata* in possessing fewer costae which are of sinusoidal rather than rectangular section; in having a generally narrower ventral muscle field without a median ridge dividing the ventral adductors, but with the adductors on a low rectangular platform; in having less well developed brachiophore bases and in having a relatively larger more robust cardinal process. Another feature apparently restricted to *T. calveri* is the tendency for the ventral valve of gerontic specimens to develop a dorsal geniculation.

Family SKENIDIIDAE Kozlowski 1929.

SKENIDIOIDES Schuchert & Cooper 1931

Type species. Skenidioides billingsi Schuchert & Cooper 1931.

Skenidioides alatus sp. nov.
Plate 8, figs 25-35.

Name. This species is very alate.

Material. Holotype UTGD 99038; Paratypes UTGD 99037, 99039, 99040, 99041, 99042, 99043.

Type locality. Lower Limestone Member of Benjamin Limestone, Westfield Section, Florentine Valley (Locality F in fig 2.11). G.R. 593798, Sheet 8212, Edition 1, 1976.

Diagnosis. Small, transverse, alate Skenidioides coarsely costate, with broad high median costa and 6 to 8 costae on each flank of subpyramidal ventral valve.

Description. Shell up to 4.7 mm wide and 2.0 mm long. Mean length-width ratio of ventral valve averages 0.38 (N = 2) and dorsal valve 0.46 (N = 2). Shell strongly ventribiconvex. Ventral valve subpyramidal, anterior slope gently concave, with low carinate fold; flanks nearly planar. Dorsal valve planar to moderately convex with large median costa forming carina on ventral valve and with incipient bifurcation appearing anteriorly. Between 6 and 8 (mode 6) costae occur on each flank. Ventral interarea approximately one quarter as high as wide, catacline. Delthyrium large, open. Dorsal interarea about one quarter as high as ventral, anacline. Notothyrium broad, open.

Teeth strong, simple, plate-like. Spondylium broad, short, free, ranging from three fifths as long as wide to equidimensional, extending anteriorly about one quarter valve length.

Brachiophores strong, pointed distally. Bases converging onto high median septum at approximately one third valve length. Cardinal process low, blade-like, continuous with median septum which extends nearly to anterior margin of valve. Sockets semi-conical, underlain by thick fulcral plates. Dorsal muscle field not preserved.

Statistics.

		Ventral Valve		
	N	M	SD	V
L/W	(0.36, 0.39)			
VI/HW	(0.26, 0.28)			
SPL/SPW	5	0.72	0.16	0.0254
SPL/L	5	0.28	0.02	0.0005
		Dorsal Valve		
L/W	(0.41, 0.51)			

Remarks. This species is considerably more transverse and possesses relatively fewer costae than most other species of the genus. Considering both of these criteria, the most similar species is *S. costatus* Cooper 1956. This species however, differs from *S. alatus* sp. nov. in that its ventral valve is strongly convex in lateral profile, whereas that of the latter is gently concave. In addition *S. costatus* has an apsacline ventral interarea whereas that of *S. alatus* is catacline.

The specimens referred to by Williams (1962) as *S* aff. *costatus* Cooper appear more closely related to the present species in that they possess a subpyramidal ventral valve. They differ however in having a semi-circular to semi-ovate shape with a length-width ratio for ventral valves of about 0.53, whereas *S. alatus* sp. nov. is considerably more transverse, with a considerably higher ventral interarea and a tendency toward having mucronate cardinal extremities. Similar comparisons could be made with specimens described from Bala by Williams (1963) as *S.* cf. *costatus* Cooper, and those from Shropshire (Williams, 1974).

Suborder DALMANELLIDINA Moore 1952

Superfamily DALMANELLACEA Schuchert 1913

Family SCHIZOPHORIIDAE Schuchert & LeVene 1929

Subfamily DRABOVIINAE Havlicek 1950

(emended Walmsley, Boucot & Harper 1969)

HIRNANTIA Lamont 1935

Type species. *Orthis sagittifera* M'Coy 1851.

Hirnantia enorme sp. nov.

Plate 8, figs 36-47; Plate 9, fig 1.

Name. This species is one of the largest forms in the assemblage in which it is found.

Material. Holotype UTGD 99501; Paratypes UTGD 99502, 99503, 99504, 99505, 99506, 99507, 99508, 99413 (i), 99413 (ii). Other material UTGD 99509-25, 99531-4.

Type locality. Westfield Sandstone, south eastern portion of Westfield Quarry, Florentine Valley (Locality 6 in fig 2.11) G.R. 587781, Sheet 8112, Edition 4, 1979.

Other localities. UTGD 99509-25, 99531-4 from Westfield Sandstone, in road cutting near turnoff to Westfield Quarry (Locality 2 in fig 2.11) G.R. 584785,Sheet 8112, Edition 4, 1979.

Diagnosis. Large, transversely ovate to subquadrate dorsibiconvex *Hirnantia* with dorsal sulcus, moderately high apsacline ventral interarea, longitudinally ovate to cordate ventral muscle field, poorly developed brachiophore bases and a large, sessile, bilobate cardinal process.

Description. Shell up to 30.4 mm wide and 25.0 mm long. Mean length-width ratio of ventral valve 0.83 (variance 0.0077), dorsal valve 0.85 (variance 0.0111). Shell dorsibiconvex, transversely ovate to subquadrate, maximum width at about midlength. Hinge width approximately four fifths maximum width. Ventral valve slightly convex with greatest convexity in posterior half. Lateral slopes slightly convex, medial portion of valve flattened, in some cases weakly sulcate. Dorsal valve moderately convex, with greatest convexity in posterior half, lateral slopes slightly flattened. Weak sulcus commonly developed. External ornament very uniformly multicostellate with between 10 to 16 costellae within 5 mm at 10 mm from beak. Costellae wider than interspaces. Ventral interarea one fifth to one quarter as high as wide, planar, apsacline. Delthyrium open. Dorsal interarea low, planar, anacline, notothyrium open, filled by cardinal process.

Teeth of moderate size, triangular, supported by well developed, strongly divergent, dental plates. Muscle field longitudinally ovate to cordate, approximately three quarters as wide as long, extending anteriorly about two fifths of valve length. Diductors semi-ovate, laterally bounding triangular median adductor scars. Adductors constitute about one third muscle field area. Vascula media broad, proximally parallel. Follicular embayments fairly prominent, extending posteriorly one eighth valve length.

Brachiophores thin, bladelike, bounding semiconical sockets which uncommonly possess discrete fulcral plates. Brachiophore bases very poorly developed, dorsally divergent. Notothyrial cavity deep, broad, apex occupied by sessile, strongly bilobed cardinal process with short shaft. Posterior adductor scars large, transversely subovate to rectangular, located anteromedially to brachiophore bases. Anterior adductors not visible. Follicular embayments prominent, extending posteriorly up to one eighth valve length in larger specimens.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	8	0.83	0.09	0.0077
MFW/MFL	7	0.75	0.11	0.0122
MFL/L	6	0.38	0.04	0.0016
HW/W	13	0.80	0.07	0.0048
		Dorsal Valve		
L/W	7	0.85	0.07	0.0048

Remarks. This species is distinctive among those of the genus *Hirnantia* in having a larger bilobed cardinal process with a shorter shaft and very poorly developed, more widely divergent brachiophore bases.

Hirnantia sp.

Plate 9, Figs 2-4.

Material. UTGD 99587-90.

Locality. Westfield Sandstone, low road cutting just to west of Westfield Quarry (Locality 3 in fig 2.11), G.R. 584783, Sheet 8112, Edition 4, 1979.

Diagnosis. Small transversely ovate to subquadrate *Hirnantia* with short broad ventral muscle field, coarsely costellate external ornament, and a large, sessile, bilobed cardinal process.

Description. Shell up to 13.0 mm wide and 8.9 mm long. Length-width ratio of single ventral valve, 0.60; of two dorsal valves, 0.65, 0.68. Shell dorsibiconvex, transversely ovate to subquadrate with maximum width at about midlength. Hinge width varying from three quarters to over nine tenths maximum width. Ventral valve slightly convex. Dorsal valve moderately and evenly convex. External ornament uniformly multicostellate with 3 or 4 costellae occurring within 1 mm at a distance of 1 mm from the beak. Costellae swollen. Ventral interarea planar, apsacline (tending to catacline). Delthyrium open. Dorsal interarea low, planar, orthocline. Notothyrium open.

Teeth not observed. Dental plates short, thick and strongly divergent. Muscle field transversely subquadrate, approximately four fifths as long as wide, extending anteriorly about two fifths of valve length.

Brachiophores thin, bladelike, bounding semiconical sockets which possess discrete fulcral plates. Brachiophore bases short, thick, dorsally divergent. Notothyrial cavity deep, broad, median third occupied by sessile, bulbous cardinal process with bilobed, longitudinally crenulate myophore and short rounded shaft. Dorsal muscle field not observed. In both valves follicular embayments are very strongly developed and may extend posteriorly for half the valve length.

Statistics.

Ventral Valve		Dorsal Valve		
UTGD 99590		UTGD 99587		99589
L/W	= 0.60	L/W	= 0.65	0.68
HW/W	= 0.92	HW/W	= 0.83	0.77
MFL/MFW	= 0.78			
MFL/L	= 0.38			

Remarks. This species occurs with *Kinnella ?kielanae* (Temple) with similar rarity. It appears to be most similar to *H. enorme* sp. nov. from which it differs in possessing a relatively broader ventral muscle field and a more transverse shell outline. These differences may be solely an artefact of the much smaller specimen size of Hirnantia sp.

KINNELLA Bergström 1968

Type species. ?Hirnantia kielanae Temple 1965

Kinnella ?kielanae (Temple)

Plate 9, figs 5-10.

Material. UTGD 99575-86.

Locality. As for Hirnantia sp.

Diagnosis. Small, subcircular to transversely ovate, ventribiconvex Kinnella with high, planar catacline ventral interarea, low anacline or orthocline dorsal interarea, short subquadrate ventral muscle field.

Description. Shell up to 10.8 mm wide and 6.9 mm long. Mean length-width ratio of ventral valve 0.71 (variance 0.0259), length width ratio of single measurable dorsal valve, 0.92. Shell ventribiconvex, subcircular to transversely ovate with maximum width near midlength. Hinge width one half to three quarters maximum width. Ventral valve subpyramidal with greatest convexity posteriorly. Dorsal valve slightly to moderately convex, with convexity even, commonly sulcate. External ornament evenly multicostellate with 3 or 4 costellae occurring within 1 mm at 1 mm from beak. Costellae swollen. Ventral interarea about one third as high as wide, planar, catacline. Delthyrium narrow, open. Dorsal interarea low, planar anacline or orthocline, notothyrium open.

Teeth not observed. Dental plates short, stout, divergent. Ventral muscle field subquadrate, about nine tenths as long as wide, extending anteriorly one third to one half valve length. Diductors subtriangular with anterior terminations rounded, extending slightly beyond, but not enclosing broad triangular adductor scar which constitutes slightly less than one third muscle field area. Muscle field bounded by variably developed ridges.

Brachiophores short, bladelike, bounding broad semiconical sockets which are underlain by large triangular fulcral plates. Brachiophore bases well developed, diverging only slightly anteriorly. Notothyrial cavity deep, narrow, occupied by thick platelike cardinal process, the shaft of which extends anteriorly up to two thirds valve length as a low median septum. Dorsal muscle field subovate, raised above valve floor, about two thirds as wide as long, extending anteriorly approximately two thirds of valve length. Posterior adductors small, longitudinally ovate to circular. Anterior adductors larger, longitudinally ovate.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	4	0.71	0.16	0.0259
VI/HW	(0.29, 0.39)			
MFL/MFW	4	0.87	0.17	0.0285
MFL/L	4	0.38	0.10	0.0095
HW/W	(0.71, 0.53)			
		Dorsal Valve		
L/W	(0.92)			
MFW/MFL	(0.60, 0.65)			
MFL/L	(0.58)			

Remarks. This rare species is tentatively assigned to *K. kielanae* (Temple) on the basis of only a few, usually fragmentary ventral interiors, one whole and two fragmentary dorsal interiors and two fragmentary ventral exteriors. The paucity of specimens precludes any significant statistical analysis. However, the meagre data obtained agrees quite closely with those of *K. kielanae* (Temple) (Temple, 1965; Bergström, 1968; Havlíček, 1977).

Family DALMANELLIDAE Schuchert 1913

Subfamily ISORTHINAE Schuchert & Cooper 1931

(emended Walmsley & Boucot 1975)

ISORTHIS Kozlowski 1929

Type species. _Dalmanella_ (_Isorthis_) _szajnochai_ Kozlowski 1929.

ISORTHIS (OVALELLA) Walmsley & Boucot 1975

Type species. _Platyorthis_ _ovalis_ Paskevicius 1962.

Isorthis (_Ovalella_) _arndellensis_ sp. nov.

Plate 9, figs 11-32.

Name. This species occurs in the type section of the Arndell Sandstone of Baillie (1979).

Material. Holotype UTGD 99466; Paratypes UTGD 99467, 99468 a & b, 99469, 99470, 99474, 99476, 99478, 99479; Other material UTGD 9947-3, 99475, 99477, 99480-500.

Type locality. Same as for _Hirnantia_ _enorme_ sp. nov.

Diagnosis. Large transverse ventribiconvex to nearly planoconvex _I_. (_Ovalella_) with weakly sulcate dorsal valve. Margins of ventral muscle field indistinct, ventral median ridge weak or absent. Margins of dorsal muscle field indistinct. Cardinal process usually bilobate.

Description. Shell up to 24.2 mm wide and 20.0 mm long. Mean length-width ratio of ventral valve 0.77 (variance 0.0021), dorsal valve 0.79 (variance 0.0026). Shell strongly ventribiconvex to nearly planoconvex, transversely ovate with maximum width at about midlength. Hinge width approximately three quarters maximum width. Ventral valve moderately convex with greatest convexity in posterior half, flattened lateral slopes. Dorsal valve nearly planar to slightly convex with indistinct sulcus, usually better developed posteriorly. External ornament multicostellate with between 12 and 14 (mode 12) costellae within 5 mm at 10 mm anterior to beak. Ventral interarea concave, apsacline. Delthyrium with variably developed arcuate pedicle callist. Dorsal interarea low, planar to slightly concave, anacline or orthocline. Notothyrium filled by cardinal process.

Teeth strong, with well developed oblique crural fossettes, supported by well developed, strongly divergent dental plates. Muscle field long, bilobed, two thirds as wide as long, extending anteriorly slightly less than one half valve length. Diductors long, fairly broad subtriangular posteriorly divided from one another by a very fine median furrow. Adductors centrally located, ovate or subrectangular. Vascula media broad, divergent. Follicular embayments short, narrow.

Brachiophores, thick, platelike, with erect bases, bounding semi-ellipsoidal sockets which are underlain by pads. Notothyrial cavity shallow, platform subcircular to triangular, posterior half occupied by broad sessile, usually bilobed cardinal process which protrudes from notothyrium. Low dorsal median ridge arising from anterior margin of notothyrial platform, extending approximately to midlength of valve. Dorsal muscle field subquadrate to ovate, indistinctly quadripartite, extending anteriorly about two fifths of valve length. Posterior adductors longitudinally ovate, deeply impressed posteriorly. Anterior adductors subquadrate to subtriangular, usually very indistinct. Follicular embayments short, narrow.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	8	0.77	0.05	0.0021
MFW/MFL	10	0.65	0.09	0.0079
MFL/L	10	0.47	0.05	0.0025
HW/W	14	0.74	0.05	0.0026
		Dorsal Valve		
L/W	11	0.79	0.05	0.0026
MFW/MFL	7	0.82	0.07	0.0051
MFL/L	8	0.41	0.03	0.0011

Remarks. In general appearance this species is perhaps most similar to I. (O.) beechillensis Walmsley & Boucot 1975 from the Llandovery of the Arisaig area, Nova Scotia, the Gaspe area, Quebec and from near Llandovery, Wales. I. (O.) arndellensis differs however in being slightly more transverse, possessing a wider hingeline and a distinctly shorter, more quadrate dorsal muscle field.

Subfamily DALMANELLINAE Schuchert 1913

ONNIELLA Bancroft 1928

Type species. Onniella broeggeri Bancroft 1928

?Onniella perplexa sp. nov.

Plate 9, figs 33-43; Plate 10, figs 1-13.

Name. Alludes to confusion over generic assignment of species.

Material. Holotype UTGD 99539 a & b (ventral valve); Paratypes UTGD 99543, 99546 a & b, 99547, 99548 a & b, 99556 a & b, 99559 a & b, 99562, 99570, 99571, 99572, 99573; Other material UTGD 99535-8, 99544-5, 99549-55, 99557-8, 99560-1, 99563-9, 99574.

Type locality. Westfield Sandstone, eastern portion of Westfield Quarry, Florentine Valley (Locality 11 in fig 2.11) G.R. 587782, Sheet 8112, Edition 4, 1979.

Diagnosis. Moderate sized, transverse, ventribiconvex or planoconvex, rarely concavoconvex *Onniella* with broadly sulcate dorsal valve; long, narrow, rarely impressed ventral muscle field; small, posteriorly bilobate cardinal process, weakly developed dorsal median ridge. Fulcral plates absent.

Description. Shell up to 17.0 mm wide and 14.3 mm long. Mean length-width ratio of ventral valve 0.76 (variance 0.0032), dorsal valve 0.77 (variance 0.0019). Shell ventribiconvex or planoconvex, rarely concavoconvex, transversely ovate with maximum width usually slightly posterior to midlength. Hinge width approximately three quarters maximum width. Ventral valve moderately convex with greatest convexity in posterior half. Lateral slopes flattened. Dorsal valve planar or slightly convex, rarely concave, with posteriorly narrow sulcus becoming broader and less distinct anteriorly. External ornament multi-constellate with between 17 and 22 (mode 22) costellae within 5 mm at 5 mm anterior to beak. Ventral interarea concave, apsacline. Delthyrium with variably developed arcuate pedicle callist. Dorsal interarea low, planar, anacline or orthocline. Notothyrium filled by cardinal process.

Teeth large triangular in section, with well developed oblique crural fossettes, supported by short, stout, dental plates. Muscle field rarely impressed, bilobed, three quarters as wide as long, extending anteriorly slightly more than two fifths valve length. Diductors long tear-shaped extending beyond but not enclosing lanceolate adductors. Vascular canals not visible. Follicular embayments prominent, extending posteriorly up to one half valve length in larger specimens.

Brachiophores, thin, platelike, with bases much more strongly divergent than their tops, and with variably developed medial swellings. Sockets variable in depth, broadly semiconical, underlain by pads. Notothyrial cavity shallow, occupied completely by small bilobed cardinal process which protrudes from notothyrium. Dorsal median ridge arising from anterior margin of notothyrial platform, indistinct, extending anteriorly about one third valve length. Dorsal muscle field impressed posteriorly, otherwise poorly defined. Follicular embayments prominent.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	16	0.76	0.06	0.0032
MFW/MFL	6	0.74	0.10	0.0101
MFL/L	6	0.43	0.05	0.0029
HW/W	21	0.75	0.07	0.0044
		Dorsal Valve		
L/W	13	0.77	0.04	0.0019

Remarks. This species is only tentatively assigned to *Onniella* as details of the ventral muscle field remain unknown. In shape and ornamentation this species is most similar to *O. fultonensis* (Foerste) and *O. emacerata* (Hall). *O. perplexa* differs from the former in having a somewhat finer ornament and in being more transverse. *O. emacerata* (Hall) differs from *O. perplexa* in having a shorter, broader, ventral muscle field and in exhibiting a relatively longer hingeline.

Suborder CLITAMBONITIDINA Opik 1934

Superfamily CLITAMBONITACEA Winchell & Schuchert 1893

Family POLYTOECHIIDAE Opik 1934

TRITOECHIA Ulrich & Cooper 1936

Type species. _Deltatreta typica_ Schuchert & Cooper 1932

Tritoechia lewisi Brown 1948

See appendix 3 for description and illustrations.

Tritoechia florentinensis Laurie 1980

See appendix 3 for description and illustrations.

Tritoechia karmbergensis Laurie 1980

See appendix 3 for description and illustrations.

?Tritoechia careyi Brown 1948

Plate 10, figs 14, 15.

Material. UTGD 97418-97422.

Locality. Mt Field Siltstone Member, Florentine Valley Formation, The Gap Section, in eastern half of high road cutting. G.R. 581707, Sheet 8112, Edition 4, 1979.

Differential diagnosis. This species has an external ornament very similar to _T. florentinensis_ Laurie 1980, but differs from that species in having a high apsacline or catacline ventral interarea and a raised ventral muscle field with a narrow median ridge extending anteriorly.

Remarks. This species is quite rare and usually quite poorly preserved. As such, little can be added to Brown's (1948) original diagnosis.

Family CLITAMBONITIDAE Winchell & Schuchert 1893

Subfamily CLITAMBONITINAE Winchell & Schuchert 1893

VELLAMO Opik 1930

Type species. *Orthis verneuili* Eichwald 1841

Vellamo sp.

Plate 10, figs 16-18.

Material. UTGD 120242 a & b, 120243.

Locality. Basal Precipitous Bluff Beds, along Precipitous Bluff track (see appendix 2).

Diagnosis. Shell up to 22.0 mm wide and 16.1 mm long. Length-width ratio of single distorted ventral valve 0.73, single dorsal valve 0.73. Shell subquadrate, ventribiconvex with high subpyramidal ventral valve and slightly convex dorsal valve. Maximum width near midlength. Hingeline about nine tenths maximum width. External ornament multicostellate with about 12 rounded costellae within 5 mm at 5 mm from beak. Costellation crossed by distinct, fine, concentric imbrication. Ventral interarea over one third as high as wide.

Ventral interior with large spondylium, anterior extent uncertain.

Dorsal interior with simple ridgelike cardinal process, widely divergent sockets ridges. Dorsal muscle field about three quarters as long as wide, deeply impressed posteriorly and medially, divided by strong median ridge. Posterior adductors transversely ovate. Anterior adductors slightly smaller, subtriangular. Arising from anterolateral extremities of both posterior and anterior scars are short low ridges.

Remarks. This species is very rare, only being represented by two specimens. As such little idea of the variation in the external ornament can be obtained. This ornament is imbricate, a feature not usually associated with *Vellamo*, however, the imbrication is fine and is assumed to be an elaborate development of the growth lineation.

Order STROPHOMENIDA Opik 1934

Suborder STROPHOMENIDINA Opik 1934

Superfamily PLECTAMBONITACEA Jones 1928

Family TAFFIIDAE Ulrich & Cooper 1936

Remarks. Liu (1976) erected the subfamily Aporthophylinae to include Taffiidae with a cardinal process. In this family he placed *Aporthophyla* and *Aporthophylina* Liu 1976. He also excluded *Toquimia* and *Pelonomia* from the Taffiidae. *Pelonomia* was assigned to the Taphrodontidae because of its type of cardinalia and its double row of dorsal tubercles. *Toquimia* was allied with the family Leptestiidae because of its transverse, shallowly concavo-convex shape, its relatively large, strong, cardinal process and its subflabellate ventral muscle field. Ross (1970a), conversely, in comparing the lophophore platform of *Toquimia* with *Anoptambonites* assumed a close relationship with the Leptellinidae for the former genus.

The author does not agree with Liu in using the presence/absence of a cardinal process as the sole criterion for differentiation of subfamilies.

APORTHOPHYLA Ulrich & Cooper 1936

Type species. Aporthophyla typa Ulrich & Cooper 1936.

Aporthophyla staiti sp. nov.

Plate 10, figs 19-36.

Name. After Mr. B.A. Stait.

Material. Holotype UTGD 120400 a & b; Paratypes UTGD 120396, 120397, 120399, 120401, 120402, 120407, 120418 a & b, 120428 a & b, 120434, 120437 a & b; Other material UTGD 120398, 120403-6, 120408-17, 120419-27, 120429-33, 120435-6, 120438-49.

Type locality. In siltstone two metres above limestone, in southern end of Blenkhorn'a Quarry, north of Railton (see fig 3.2).

Diagnosis. Transversely subquadrate to semi-ovate, moderately concavoconvex Aporthophyla with multicostellate external ornament, apical pseudodeltidium, short broad ventral muscle field, thin bladelike cardinal process and with subperipheral rims well developed in both valves.

Description. Shell up to 21.2 mm wide and 16.0 mm long. Mean length width ratio of ventral valve 0.69 (variance 0.0170), dorsal valve 0.74 (variance 0.0073). Shell moderately concavoconvex, transversely subquadrate to semi-ovate with maximum width usually just anterior to hingeline. Hinge width about nine tenths maximum width. Ventral valve moderately convex with maximum convexity in posterior half. Lateral slopes flattened. Dorsal valve slightly concave with variably developed sulcus, usually better developed posteriorly. External ornament evenly to unevenly multicostellate with between 15 and 20 (mode 15) costellae occurring within 5 millimetres at 5 millimetres from the beak. Ventral interarea low, planar, apsacline or orthocline. Delthyrium partly closed by apical pseudodeltidium. Dorsal interarea about half height of ventral, planar, anacline, catacline or hypercline. Notothyrium completely covered by large convex chilidium.

Teeth large boss-like with well developed shelf-like fossettes. Dental plates short, thick, giving rise to well developed muscle bounding ridges. Ventral muscle field subpentagonal, about three quarters as long as wide, mainly confined to delthyrial cavity, extending anteriorly slightly less than three tenths valve length. Adductors broad, triangular, diductors narrow, subtriangular to semi-ovate, extending slightly beyond adductors. Ventral mantle canal system saccate. Ventral subperipheral rim well developed with median portion often weaker than anterolateral and lateral portions.

Cardinal process thin, bladelike, directed posteriorly, sometimes with low poorly developed lateral lobes near base. Notothyrial platform short, triangular, roll like, buttressed laterally by low strongly divergent socket ridges. Sockets deep, semiconical. From anterior margin of notothyrial platform arises a strong rounded median ridge anteriorly developing into a broad rise reflecting the external dorsal sulcation. Dorsal adductor field quadrate, about three quarters as wide as long, extending anteriorly to about half valve length. Anterior adductors obscure, probably trapezoidal. Posterior adductors sub-quadrate to circular, of similar size as anterior scars, posterior margins impressed below notothyrial platform. Dorsal mantle canal system probably saccate. Vascula media subparallel, adjacent to median ridge. Vascula myaria extending anterolaterally from anterolateral margins of adductor field, bifurcating, with one branch directed anteriorly the other directed posterolaterally. Subperipheral rim very strongly developed, very close to valve margin.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	13	0.69	0.13	0.0170
MFL/MFW	13	0.77	0.18	0.0324
MFL/L	9	0.28	0.04	0.0020
HW/W	5	0.91	0.04	0.0018
		Dorsal Valve		
L/W	10	0.74	0.09	0.0072

Remarks. This species differs from *A. typa* Ulrich & Cooper 1936 in having a more even multicostellate external ornament, a stronger dorsal subperipheral rim and more rounded cardinal extremities. It differs from *A. kasachstanica* Rukavishnikova 1956 again in having a more even multicostellate ornament and in lacking a carinate ventral valve with consequent internal median groove. *A. perelegans* Liu 1976 differs in being more transverse, having a longer hingeline with more acute cardinal extremities and a finer external ornament.

Family LEPTESTIIDAE Opik 1933

Remarks. The classification of the Plectambonitacea proposed by Williams (1965) is largely based on the presence or absence of an "undercut platform" and if present, its size. Thus, forms without an undercut platform are assigned to the Taffiidae Ulrich & Cooper and the Leptestiidae Opik, whereas those possessing an undercut platform are placed in the family Leptellinidae Ulrich & Cooper. Other genera whose cardinalia are elevated above an alveolus and that lack undercut platforms are segregated into the family Sowerbyellidae Opik.

Use of the criterion of the presence or absence of an undercut platform has led to assignments of certain genera which make some of these families appear heterogeneous in features such as the musculature and vascular systems. For instance, the family Leptestiidae includes forms with a short triangular ventral muscle field (*Leptestia*, *Spanodonta* and members of the subfamilies Isophragmatinae and Taphrodontinae) as well as forms with a very large bilobed ventral muscle field (eg. *Sowerbyites*, *Titanambonites* etc.). Furthermore, some genera have a transversely divided dorsal adductor field, with the posterior scar located immediately posterior to the anterior scar (eg. *Leptestia*, *Spanodonta*, *Titanambonites*) while others have an obliquely divided dorsal adductor field, with the posterior scar located posterolateral to the anterior scar (eg. *Sowerbyites*, *Apatomorpha* and genera of the subfamilies Isophragmatinae and Taphrodontinae). The mantle canal systems correlate more closely with the

Williams (1965) classification. The genera of the subfamily Leptestiinae have saccate systems in both valves (where known) whereas the genera assigned to the other two subfamilies (Isophragmatinae and Taphrodontinae) have digitate systems in both valves (where known).

The overriding importance placed on the presence or absence of an undercut platform has also led to assignments of certain genera which otherwise appear quite anomalous. Such examples are the tentative comparison of *Toquimia* to the Leptellinidae by Ross (1970a) and the assignment of *Ishimia* to the Leptellinidae by Nikitin (1974). In the former case, this assignment was questioned by Liu (1976) who believed *Toquimia* to be much better assigned to the Leptestiidae (see remarks on Taffiidae). In the latter case, though Nikitin noted the great similarity of *Ishimia* to *Titanambonites* he disregarded all morphological criteria other than the presence or absence of a diaphragm to place these two genera in completely different families. The use of the diaphragm criterion is further bought into question by the existence of *Lepidomena* gen. nov.. This genus is essentially identical to *Ishimia* but possesses no diaphragm. In all other internal features, particularly the ventral and dorsal musculature and the ventral and dorsal mantle canal systems the two genera can not be differentiated. The similarities of the three genera *Titanambonites*, *Ishimia* and *Lepidomena* gen. nov. are so striking the author finds it impossible to believe anything but a close genetic relationship exists between them. Because these genera form a homogeneous group within the Leptestiidae they are here separated from the Leptestiinae into a new subfamily Titanambonitinae.

Subfamily TITANAMBONITINAE subfam. nov.

Diagnosis. Subquadrate, concavoconvex, multicostellate or parvicostellate. Pseudodeltidium large. Chilidium entire. Ventral muscle field large, bilobate, with long, divergent lath-like diductors extending well beyond but not enclosing transversely ovate to rectangular adductor field. Diductors terminate anteriorly in variably developed callosities. Teeth with well developed shelf-like fossettes. Ventral mantle canal system saccate. Dorsal muscle field transversely divided. Socket ridges short, divergent, in some genera free distally. Cardinal process trilobate or high, bladelike. Median ridge variably developed. Subperipheral rim variably developed, in some genera developed as diaphragm. Dorsal mantle canal system saccate.

Genera assigned.

Titanambonites Cooper 1956

Ishimia Nikitin 1974

Lepidomena gen. nov.

and questionably Goniotrema Ulrich & Cooper 1936

LEPIDOMENA gen. nov.

Name. Refers to the blade-like cardinal process plus standard stophomenid ending.

Type species. *Lepidomena pulchra* sp. nov.

Diagnosis. Concavoconvex, subovate to subquadrate. Multicostellate, with or without widely spaced accentuated costellae. Ventral interarea orthocline or apsacline. Pseudodeltidium well developed, convex. Dorsal interarea hypercline. Chilidium well developed with median ridge. Ventral muscle field bilobate, diductors long, divergent, extending beyond but not enclosing broad median adductors. Diductors terminate in variably developed callosities. Teeth strong, crural fossettes well developed, dental plates absent. Cardinal process bladelike, very high. Socket ridges short, delicate, free distally. Dorsal median septum low, narrow. Dorsal subperipheral rim well developed.

Remarks. This genus is most similar to *Titanambonites* Cooper 1956 and *Ishimia* Nikitin 1974, however, it differs from the former in having a high bladelike cardinal process, delicate bladelike socket ridges which are free distally and a multicostellate external ornament. *Lepidomena* differs from the latter genus in having a high bladelike cardinal process, a low narrow median ridge and in lacking a brachial diaphragm.

Lepidomena pulchra sp. nov.
Plate 11, figs 26-33; Plate 12, figs 1-10.

Name. Alludes to beautiful preservation.

Material. Holotype UTGD 99906; Paratypes UTGD 99907, 99908, 99911, 99913, 99917, 99921, 99923, 99927, 99930; Other material UTGD 99910, 99912, 99914-16, 99918-20, 99922, 99924-26, 99928-29, 99931-34.

Type locality. Base of Lower Limestone Member, Benjamin Limestone, 200 m north of Settlement Road, Florentine Valley (Locality 6 on section A, fig 2.9), G.R. 568863 Sheet 8112, Edition 4, 1979.

Diagnosis. Lepidomena with strong dorsal subperipheral rim, trail at an angle of 70° to 80° to plane of visceral disc. Ventral muscle field broad, relatively short, with well developed callosities at anterior end of diductors.

Description. Shell up to 22.2 mm wide and 17.9 mm long. Mean length-width ratio for ventral valve 0.76 (variance 0.0039), dorsal valve 0.69 (variance 0.0043). Shell concavoconvex, subovate to subquadrate, with maximum width at or slightly anterior to hingeline. Ventral valve moderately convex, with maximum convexity usually in posterior half. Lateral slopes slightly flattened. Dorsal valve moderately concave with maximum convexity at midlength or in posterior half. Valve posteriorly narrowly sulcate. External ornament variably multicostellate, some specimens having very uniform costellae, others have widely spaced slightly larger costellae separated by from 3 to 7 smaller costellae. Within 5 mm at a distance of 5 mm from the beak there are from 19 to 24 (mode 24) costellae. Concentric fila very fine and poorly developed. Ventral interarea less than one tenth as high as wide, planar, orthocline or rarely apsacline. Delthyrium covered by narrow, strongly convex pseudodeltidium. Dorsal interarea half as high as ventral, planar, hypercline. Notothyrium covered completely by moderately convex chilidium with narrow median ridge.

Teeth strong, triangular in section with well developed shelf-like crural fossettes. Dental plates absent. Ventral muscle field bilobed, about three quarters as long as wide, extending anteriorly just over two fifths valve length. Diductors lath-like, strongly divergent anteriorly, extending well beyond but not enclosing short, broad, median adductor field. Anteriorly diductor scars terminate in moderately well developed callosities. Adductor field transversely rectangular, each adductor scar tear shaped, with cusp directed posteriorly. Ventral mantle canal system saccate, with vascula media diverging in two main branches from the anterior extremity of each diductor scar. Gonocoels small, reniform, laterally adjacent to diductor scars. Interior of ventral valve ornamented by radial rows of endospines.

Cardinal process high, thin, bladelike, extending posteroventrally well beyond posterior margin of valve. Socket ridges short, delicate, platelike, free distally, bounding deep semiconical sockets underlain by variably developed socket pads. Median septum thin, low, usually highest at about valve midlength, truncated anteriorly at well developed subperipheral rim. Trail fairly long, at an angle of 70° to 80° to plane of visceral disc. Visceral disc less than three quarters as long as wide, extending anteriorly about three quarters valve length. Dorsal adductor field indistinct. Anterior scars raised anteriorly, narrowly triangular, apices directed posteromedially, separated from median septum by vascula media. Posterior scars obscure. Dorsal mantle canal system saccate with broad well impressed vascula media adjacent to median septum. Vascula myaria broad, well impressed. Gonocoels subtriangular nearly extending to lateral margins of visceral disc.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	13	0.76	0.06	0.0039
VI/HW	13	0.08	0.01	0.0001
MFL/MFW	15	0.075	0.07	0.0053
MFL/L	8	0.44	0.06	0.0032
		Dorsal Valve		
L/W	11	0.69	0.07	0.0043

Lepidomena fortimuscula sp. nov.

Plate 12, figs 11-17

Name. Refers to comparatively large muscle field.

Material. Holotype UTGD 99935; Paratypes UTGD 99937, 99942, 99947, 99952, 99954, 99955, 99956, 99957, 99960; Other material UTGD 99936, 99938-41, 99943-46, 99948-51, 99953, 99958-9, 99961-68.

Type locality. Upper Cashions Creek Limestone, 200 m north of Settlement Road, Florentine Valley (Locality 4 on section A, fig 2.9). G.R. 569863, Sheet 8112, Edition 4, 1979.

Diagnosis. *Lepidomena* with variably developed dorsal sub-peripheral rim, trail at an angle of 40° to 50° to plane of visceral disc. Ventral muscle field long, equidimensional, with weakly developed callosities at anterior end of diductors.

Description. Shell up to 26.0 mm wide and 21.2 mm long (dorsal valve). Mean length-width ratio of ventral valve 0.77 (variance 0.0045), dorsal valve 0.71 (variance 0.0060). Shell concavoconvex, subovate to subquadrate, with maximum width at, or slightly anterior to, hingeline. Ventral valve moderately convex, convexity even or greatest in posterior half. Lateral slopes slightly flattened. Dorsal valve moderately concave with concavity fairly even. Valve posteriorly weakly sulcate. External ornament variably multicostellate, some specimens with fairly uniform costellae, others with widely spaced accentuated costellae separated by from three to eight lesser costellae. At a distance of 5 mm from the beak, there are from 22 to 24 (mode 24) costellae within 5 mm. Regularly spaced, well developed, fine, concentric fila cross the costellae. There are 6 fila per millimetre. Ventral interarea about one tenth as high as wide, planar, orthocline. Delthyrium covered by narrow, strongly convex pseudodeltidium. Dorsal interarea about half as high as ventral, planar, hypercline. Notothyrium covered by moderately convex chilidium.

Teeth strong, triangular in section with well developed shelf-like crural fossettes. Dental plates absent. Ventral muscle field bilobed, about as long as wide, extending anteriorly just over half valve length. Diductors lath-like, weakly divergent anteriorly, extending beyond but not enclosing rectangular median adductor field. Anteriorly, diductor scars terminate in poorly developed callosities. Adductor field longitudinally rectangular to square, scars obscure. Ventral mantle canal system saccate with vascula media diverging in two main branches from the anterior extremity of each diductor scar. Genocoels reniform, laterally adjacent to diductors. Interior of ventral valve ornamented by radial rows of endospines.

Cardinal process high, thin, bladelike, extending posteroventrally well beyond posterior margin of valve. Socket ridges short, delicate, platelike, free distally, bounding deep semiconical sockets. Median septum thin, low to obscure, usually highest at about one half valve length, truncated anteriorly by variably developed subperipheral rim. Trail fairly long, at an angle of from 40° to 50° to plane of visceral disc. Visceral disc less than three quarters as long as wide, extending anteriorly over three quarters valve length. Dorsal adductor field obscure. Dorsal mantle canal system probably saccate with broad well impressed vascula media adjacent to median septum, remainder of system obscure.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	8	0.77	0.07	0.0045
VI/HW	13	0.09	0.01	0.0001
MFW/MFL	14	0.99	0.09	0.0072
MFL/L	9	0.55	0.04	0.0018
		Dorsal Valve		
L/W	11	0.71	0.08	0.0060

Remarks. This species differs from *L. pulchra* sp. nov. in possessing more strongly developed concentric fila crossing the multicostellate ornament and a relatively longer, narrower ventral muscle field, with the median area bounded by the diductors having nearly parallel sides. In *L. pulchra* this median area is distinctly trapeziform. *L. fortimuscula* also possesses much less strongly developed callosities anterior to the diductor scars and a less pronounced dorsal subperipheral rim with a less abrupt geniculation.

Family SOWERBYITIDAE fam. nov.

Diagnosis. Subquadrate to semi-ovate, concavoconvex to nearly planoconvex, unequally parvicostellate. Pseudodeltidium apical or large. Chilidium large. Ventral muscle field large, bilobate with long divergent lath-like diductors extending well beyond and in some genera, surrounding small median adductors. Teeth with well developed shelf-like fossettes or with accessory teeth. Ventral mantle canal system saccate. Dorsal muscle field obliquely divided. Socket ridges short, divergent, free distally. Cardinal process trilobate. Median ridge usually well developed. Subperipheral rim variably developed. Dorsal mantle canal system saccate.

Genera assigned.

Sowerbyites Teichert 1937

Apatomorpha Cooper 1956

Glyptambonites Cooper 1956

Palaeostrophomena Holtedahl 1916 and questionably

Toquimia Ulrich & Cooper 1936.

Remarks. As noted by Percival (1979a, p.106) the dorsal muscle field of *Titanambonites* is similar to that of *Leptestia* in that the adductors are divided into posterior and anterior pairs by transverse proximal portions of the vascula myaria. *Sowerbyites* (and others) conversely has a dorsal muscle field divided by oblique vascula myaria. The author believes that this dichotomy in the Leptestiinae Opik as portrayed by Williams 1965 warrants recognition at a family level.

SOWERBYITES Teichert 1937

Type species. *Sowerbyites medioseptata* Teichert 1937.

Sowerbyites vesciseptus Percival 1979

Plate 10, figs 37-54; Plate 11, figs 1-3

Material. UTGD 99803-15.

Locality. Lower Limestone Member, Benjamin Limestone, South of Sixteen Road (Locality 4a on Section 3, fig 2.9). G.R. 561856 Sheet 8112, Edition 4, 1979.

Diagnosis. Semicircular to semiovate, moderately concavo-convex, unequally parvicostellate *Sowerbyites* with large bilobate ventral muscle field and short, narrow, poorly developed dorsal submedian septa

Description. Shell up to 25.8 mm wide and 16.2 mm long. Mean length-width ratio of ventral valve 0.65 (variance 0.0039), dorsal valve 0.59 (variance 0.0011). Shell concavoconvex, semicircular to semi-ovate, with maximum width usually at hingeline. Ventral valve slightly to moderately convex. Convexity quite irregular, some with maximum convexity in anterior half, others in posterior half. Dorsal valve slightly to moderately concave with maximum concavity in anterior half of valve. External ornament unequally parvicostellate with distance between accentuated costellae from 0.5 to 1.1 mm at anterior margin. Intervening costellae very fine and faint. Comae absent in some specimens, in others covering entire external surface, obscuring radial ornament. Ventral interarea low, planar or slightly concave, apsacline or orthocline. Pseudodeltidium not preserved. Dorsal interarea approximately half as high as ventral, planar, catacline or hypercline. Chilidium not preserved.

Teeth strong, platelike, separated by slit-like fossettes from lower, plate-like, accessory teeth. Dental plates absent. Ventral muscle field strongly bilobate, over four fifths as long as wide, extending anteriorly slightly over one half valve length. Diductors long, broad, diverging from one another at about 90°, terminating in variably developed callosities. Adductors ovate, located posteriorly, enclosed by diductors. Ventral mantle canal system saccate with vascula media arising from anterior extremities of diductors as four main branches which bifurcate almost immediately. Vascula genitalia poorly impressed.

Cardinal process large, boss-like trilobate posteriorly, with strong median lobe extending ventrally nearly to apex of delthyrium. Lateral lobes lower, weaker. Socket ridges thick, bladelike, distally free, diverging at about 30° from hingeline. Sockets narrow slit-like. Accessory sockets weakly impressed along ventral edge of socket ridges. Median septum strong, high anteriorly, truncated by well developed subperipheral rim. Visceral disc about three fifths as long as wide, extending anteriorly about three quarters valve length. Submedian septa usually low, narrow, slightly divergent anteriorly, truncated at anterior margin of dorsal adductor field. Dorsal adductor field large, bilobate, three quarters as long as wide, extending anteriorly slightly less than one half valve length. Anterior adductors narrow, linear, located adjacent to submedian septa, separated from larger semiovate posterior scars by broad anterolaterally directed vascula myaria. Vascula media broad, adjacent to median septum. Vascula genitalia large reniform, variably impressed.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	6	0.65	0.06	0.0039
VI/HW	5	0.06	0.01	0.0001
MFL/MFW	(0.83, 0.84)			
MFL/VL	(0.51, 0.54)			
		Dorsal Valve		
L/W	10	0.59	0.03	0.0011
MFL/MFW	5	0.75	0.04	0.0013
MFL/L	5	0.47	0.05	0.0022

Remarks. These specimens are vary similar to *S. vesciseptus* Percival 1979 from New South Wales. Only very minor differences between the two samples can be detected. They are, a slightly less strongly concavoconvex profile and less anteriorly divergent socket ridges in the N.S.W. specimens. These features are, however, quite variable in the Florentine Valley specimens and are therefore not considered worthy of formal recognition.

APATOMORPHA Cooper 1956

Type species. *Rafinesquina pulchella* Raymond 1928

Apatomorpha melrosensis sp. nov.
Plate 11, figs 4-25.

Name. Type specimens are from near Melrose Creek.

Material. Holotype UTGD 120322; Paratypes UTGD 120325, 120328, 120329, 120311, 120338, 120351, 120356, 120358, 120363, 120369, 120374, 120378, 120380, 120381; Other material UTGD 120320-1, 120323-4, 120326-7, 120330, 120332-7, 120339-50, 120352-5, 120357, 120359-62, 120364-8, 120370-3, 120375-7, 120379, 120382-95.

Type locality. In farm track 5 metres west of fence, above southern end of first road cutting north of bridge over Melrose Creek (Locality A in fig 3.4). G.R. 42679223 Devonport 8115-1-S 1:31,680.

Diagnosis. Shell small, transversely subquadrate to semi-ovate, plano- to concavoconvex, unequally parvicostellate with short bilobate ventral muscle field. Dorsal median rise broad, strong, surmounted by thin septum. Socket ridges very short, cardinal process bulbous posteriorly trilobate.

Description. Shell up to 14.0 mm wide and 9.55 mm long. Mean length-width ratio of ventral valve 0.62 (variance 0.0153), dorsal valve 0.62 (variance 0.0190). Shell plano- to concavoconvex with maximum width at hingeline. Ventral valve moderately convex, convexity fairly even. Lateral slopes well flattened, mid-portion subcarinate. Dorsal valve planar to slightly concave with distinct sulcus, more prominent posteriorly. External ornament unequally parvicostellate with from eight to eleven costellae per millimetre at anterior margin, with accentuated costellae separated from one another by two to five smaller costellae. Ventral interarea low, planar, apsacline, details of delthyrium not observed. Dorsal interarea about half as high as ventral, planar, catacline or hypercline. Chilidium large, strongly convex.

Teeth small, triangular in section, separated from lower plate-like accessory teeth by slit-like fossettes. Dental plates strongly divergent, very short, thickened, some specimens have umbonal chambers filled entirely by secondary shell material. Ventral muscle field strongly bilobate, about four fifths as long as wide, extending anteriorly about one third valve length. Diductors long, ovate, diverging anteriorly. Adductors not visible. Ventral mantle canal system saccate with broad, usually well impressed vascula media extending from anterior extremities of diductors to about two thirds valve length where they bifurcate. Bifurcation point in some specimens marked by low, rounded callosity. Branches of vascula media extend concentrically. Gonocoels not well impressed.

Cardinal process boss-like, trilobate posteriorly with lateral lobes slightly weaker than median lobe. Socket ridges short, thin, bladelike, free distally, bounding small semiconical sockets. Accessory sockets variably developed, located medial of posterior portion of socket ridges. Median septum thin, low, surmounting broad median rise, the whole truncated by variably developed subperipheral rim located at about three quarters valve length. Dorsal mantle canal system saccate with vascula media reduced, poorly impressed, parallel and adjacent to median ridge, bifurcating or trifurcating near subperipheral rim.

Vascula myaria well developed, usually strongly impressed, often forming boundaries of broad median rise, bifurcating at about two thirds valve length with minor branch continuing radially, major branch curving concentrically. Gonocoels not well impressed.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	23	0.62	0.12	0.0153
MFL/MFW	14	0.84	0.10	0.0092
MFL/L	14	0.34	0.04	0.0015
MFW/W	15	0.24	0.04	0.0012
		Dorsal Valve		
L/W	23	0.62	0.14	0.0190

Remarks. These specimens have undergone considerable distortion and the statistical data given above may not be entirely reliable. This species differs from the only other known species, A. pulchella (Raymond) in being much more transverse, slightly more convex in the ventral valve and in having the vascular canals of both valves extending further anteriorly before bifurcating. This latter feature gives rise to more concentrically oriented major branches of the ventral vascula media and the dorsal vascula myaria.

Family LEPTELLINIDAE Ulrich & Cooper 1936

Subfamily LEPTELLINAE Williams 1965

LEPTELLA Hall & Clarke 1892.

Type species. _Leptaena sordida_ Billings 1862

Remarks. The species described below, although assigned to the genus _Leptella_ does not possess an undercut platform. Its other properties however, particularly the dentition, musculature and what remains of the vascular canal system indicate an assignment to the Leptellinidae rather than the Taffiidae. These criteria, in the opinion of the author are of considerably more taxonomic importance than whether or not a subperipheral rim is undercut.

Leptella corbetti sp. nov.

Plate 12, figs 18-33.

1974 _Spanodonta_ cf _hoskingae_ Prendergast; Corbett & Banks. Plate 2 figs 21-23 (no description)

Name. After Dr. K.D. Corbett who first mapped the Florentine Valley in detail.

Material. Holotype UTGD 97459; Paratypes UTGD 97457, 97460, 97463, 97464, 97465, 97467, 97468, 97469, 97472, 97474, 97475, 97476; Other material UTGD 97458, 97461-2, 97466 a & b, 97470-1, 97473, 97477.

Type locality. Nodular siltstones, lower Karmberg Limestone, intersection of Nine Road and Florentine Road, Florentine Valley. (Locality C, fig 2, Appendix 3) G.R. 568745, Sheet 8112, Edition 4 1979.

Diagnosis. Moderately large, concavoconvex, subquadrate to transversely ovate, paucicostellate *Leptella* with apical pseudodeltidium and large convex chilidium, small triangular ventral muscle field, tuberculate rise in middle of ventral valve, and well developed dorsal median septum.

Description. Shell up to 10.8 mm wide and 7.7 mm long. Mean length-width ratio for ventral valve 0.73 (variance 0.0037), dorsal valve 0.61 (variance 0.0013). Shell concavoconvex, subquadrate to transversely ovate, with maximum width immediately anterior to hingeline. Hinge width approximately nine tenths maximum width. Cardinal extremities rounded. Ventral valve moderately and evenly convex in lateral and anterior view. Dorsal valve slightly concave, with greatest concavity in anterior half of valve. Posteriorly weakly sulcate. External ornament paucicostellate with 10 to 12 primary costellae arising at margin of protegulum. One secondary costella arises (by intercalation) between each pair of primary costellae at a distance of 2 to 3 mm from beak. At 5.0 mm from the beak, adjacent costellae are separated by 1.4 to 1.6 mm. Ventral interarea about one eighth as high as wide, planar, apsacline or orthocline. Pseudodeltidium convex and apical. Dorsal interarea slightly lower than ventral, planar, anacline or catacline. Notothyrium covered by large convex chilidium.

Teeth strong, boss-like, with large oblique shelf-like fossettes, supported by poorly developed thick dental plates. Ventral muscle field about two thirds as wide as long, subtriangular, restricted to semiconical delthyrial cavity which is anteriorly raised above valve floor, extending anteriorly over one quarter valve length. Diductors narrow subtriangular, not enclosing broad, triangular, median adductors. Poorly defined tuberculate rise occurs anterior to muscle field at about midlength. Vascula media arise from anterolateral margins of muscle field and diverge anteriorly.

Socket ridges high, buttressed by strong rounded transverse roll of callus which forms anterior margin of notothyrial platform. Sockets deep, semiconical to semi-ellipsoidal. Socket ridges continuous with low, thick, chilidial plates which bound a narrow conical notothyrial cavity. Cardinal process absent. Broad rounded median septum, arises from anterior margin of notothyrial platform, highest anteriorly, truncated by well developed subperipheral rim. Dorsal adductor field subquadrate, with anterior adductor scars narrowly triangular, apices directed posteriorly, separated from median septum by vascula media. Posterior adductors narrowly triangular with apices directed anteriorly, separated from anterior scars by anterolaterally directed vascula myaria. Dorsal mantle canal system probably digitate. Valve interiorly tuberculate anteriorly and lateral of subperipheral rim, and on apex of median septum. Remainder smooth.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	11	0.73	0.06	0.0037
VI/HW	10	0.12	0.01	0.0002
MFW/MFL	9	0.65	0.10	0.0090
MFL/L	9	0.28	0.05	0.0020
HW/W	13	0.91	0.03	0.0010
		Dorsal Valve		
L/W	7	0.61	0.04	0.0013

Remarks. This species is perhaps most similar to *L. sordida* (Billings) but differs in that the latter has a higher ventral interarea, a considerably broader notothyrial platform, an undercut platform and does not possess an entire chilidium. *L. nevadensis* Ulrich & Cooper differs in being much more strongly inflated. *L. grandis* Xu has a considerably longer hingeline and more closely spaced costellae. *L. hubeiensis* Zeng is more inflated, less transverse, has more closely spaced costellae, lacks the pustulose median rise in the ventral valve and has well developed lateral bounding ridges surrounding the dorsal muscle field.

Subfamily LEPTELLININAE Ulrich & Cooper 1936

RAILTONELLA gen. nov.

Name. Type locality of type species is near Railton, northern Tasmania.

Type species. *Railtonella scanloni* sp. nov.

Diagnosis. Concavoconvex, semicircular to subquadrate, multicostellate. Ventral interarea apsacline with small apically perforate pseudodeltidium. Dorsal interarea anacline or catacline. Notothyrium covered by chilidium. Ventral valve with weak subperipheral rim and short triangular ventral muscle field confined to delthyrial cavity. Adductors broad, triangular, about as long as diductors. Ventral mantle canal system saccate. Dorsal valve with well developed median septum which peaks at the anterior margin of the raised adductor field and continues to the undercut subperipheral rim as a low cuneiform ridge. Cardinal process variable in height, bladelike. Dorsal mantle canal system digitate or lemniscate.

Remarks. This genus is most similar to *Calyptolepta* Neuman 1976b. It differs from this latter form in having a dorsal median ridge which extends only slightly beyond the anterior margin of the raised adductor field. Forward of this a very low cuneiform rise extends to the margin of the visceral disc.

It is almost certain that *L. sinensis* Xu et. al. 1974 from the lower Middle Ordovician Shizipu Formation of Guizhou Province, China also belongs to this genus.

Railtonella scanloni sp. nov.
Plate 13, figs 9-30.

Name. After Mr. A.P. Scanlon who first collected fossils from Caroline Quarry.

Material. Holotype UTGD 99825; Paratypes UTGD 99816, 99817, 99818, 99819, 99821, 99822, 99826, 99831, 99833, 99834, 99836, 99837, 99838, 99839, 99842; Other material UTGD 99820, 99823-4, 99827-30, 99832, 99835, 99840-1, 99843-5, 120293-319.

Type locality. 150 m North northwest of small costean on north side of Caroline Quarry Road 400 m from junction with Newbed Road, West of Railton (Locality A, fig 3.2).

Diagnosis. As for genus.

Description. Shell up to 9.0 mm wide and 6.2 mm long. Mean length-width ratio of ventral valve 0.68 (variance 0.0014), dorsal valve 0.64 (variance 0.0073). Shell concavo-convex, semicircular to semiovate with maximum width at hingeline. Ventral valve strongly convex with convexity even or greatest in posterior half. Lateral slopes flat or concave, mid portion with broad subcarinate fold. Dorsal valve moderately to slightly, evenly concave with broad well developed sulcus. Posterolateral areas of valve surface planar to slightly convex. External ornament finely multicostellate with between 5 and 8 (mode 7) costellae occurring within 1.0 mm at anterior margin. Ventral interarea about one tenth as high as wide, planar, apsacline. Delthyrium partly covered by small moderately convex apically perforate pseudodeltidium. Foramen small. Dorsal interarea about half as high as ventral, planar, anacline or catacline. Notothyrium completely covered by large convex chilidium.

Teeth large, subtriangular in section, separated from weak platelike accessory teeth by slitlike fossettes. Dental plates very short, thick. Ventral muscle field, triangular, about three quarters as long as wide, confined to delthyrial cavity, extending anteriorly about one quarter valve length. Diductors narrow, triangular, extending anteriorly about as far as triangular median adductors. Ventral mantle canal system saccate with broad strongly divergent vascula media. Weak ventral, radially striate, subperipheral rim developed, strongest laterally and anterolaterally, absent in narrow anteromedian sector of valve. Anterior to ventral muscle field, at about valve midlength occur two short, low, anteriorly convergent ridges which coalesce to form a V-shaped platform.

Cardinal process variable, from high blade to low ridge, occupying narrow posteriorly or posteroventrally facing notothyrial platform. Socket ridges plate-like, free distally. Sockets deep semiconical, underlain by socket pads. Accessory sockets weakly impressed along ventral edge of socket ridges. Median septum thick, high, variable in its connection with notothyrial platform, extending anteriorly about two thirds valve length to just beyond anterior margin of raised dorsal adductor field. Septum connected to anterior margin of visceral disc by low, cuneiform ridge. Undercut platform well developed, radially striate, extending anteriorly over four fifths valve length. Dorsal adductor field large, subcircular to subquadrate, about as long as wide, extending anteriorly just over half valve length. Anterior adductors small, subtriangular, raised anteriorly, separated from median septum by narrow vascula media. Posterior adductors larger, narrowly subtriangular, with apices directed anterolaterally, posteriorly impressed, anteriorly raised, separated from anterior scars by broad anterolaterally directed vascula myaria. Dorsal mantle canal system digitate or lemniscate with vascula media adjacent to median septum, vascula myaria broad, directed anterolaterally, vascula genitalia indistinct.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	10	0.68	0.04	0.0014
VI/HW	8	0.10	0.02	0.0004
MFL/MFW	4	0.77	0.09	0.0072
MFL/L	4	0.24	0.05	0.0021
		Dorsal Valve		
L/W	14	0.64	0.09	0.0073
MFW/MFL	10	0.99	0.13	0.0168
MFL/L	9	0.54	0.05	0.0024

Remarks. *R. scanloni* differs from *R. sinensis* (Xu et. al. 1974) in having a very even multicostellate external ornament, a stronger median septum and a weakly developed ventral subperipheral rim.

LEPTELLINA Ulrich & Cooper 1936

Type species. *Leptellina tennesseensis* Ulrich & Cooper 1936

Leptellina sulcata sp. nov.

Plate 12, figs 34-47; Plate 13, figs 1-6.

Name. This species is quite strongly sulcate.

Material. Holotype UTGD 99899; Paratypes UTGD 99878, 99880, 99881, 99882, 99889, 99894; Other material UTGD 99879, 99883-5, 99887-8, 99890-3, 99895-98, 99900-05.

Type locality. Upper Karmberg Limestone, near crest of hill, south of intersection of Florentine Road and Manning Road. (Locality A in fig 2.7) G.R. 546926, Sheet 8112 Edition 4, 1979.

Diagnosis. Small subquadrate *Leptellina* with strong dorsal sulcus and ventral fold, short broad bilobate ventral muscle field and very low indistinctly trilobate cardinal process.

Description. Shell up to 8.4 mm wide and 5.6 mm long. Mean length-width ratio of ventral valve 0.66 (variance 0.0013), dorsal valve 0.62 (variance 0.0016). Shell concavoconvex, subquadrate with maximum width at or near hingeline. Ventral valve moderately to strongly convex with maximum convexity in posterior half. In anterior view, with strong rounded fold and planar or slightly concave lateral slopes. Dorsal valve slightly concave with well developed median sulcus and planar or slightly convex posterolateral portions of valve. External ornament poorly preserved, probably unequally parvicostellate with 0.2 to 0.4 millimetres between accentuated costellae at anterior margin. Smaller costellae rarely observed. Some ventral valves have a prominent, thickened median costella. Ventral interarea about one tenth as high as wide, planar, apsacline. Ventral interarea, about one tenth as high as wide, planar, apsacline. Pseudodeltidium not preserved. Dorsal interarea about half as high as ventral, planar, catacline or hypercline. Chilidium not preserved.

Teeth strong, platelike, nearly parallel to hingeline, separated from thin platelike accessory teeth by narrow slit-like fossettes. Dental plates very short, very thick, strongly divergent. Ventral muscle field, bilobate, over two thirds as long as wide, extending anteriorly about one third valve length. Diductors large, subovate, with anterior margins raised and evenly rounded, extending beyond but not enclosing fairly narrow, lath-like median adductors, which may be raised slightly above diductors. Vascula media often raised proximally, divergent anteriorly.

Cardinal process broad very low, posteriorly broadly trilobate. Socket ridges platelike, free distally. Sockets deep, slit-like. Accessory sockets weakly impressed anteromedial of socket ridges. Median septum narrow, low, surmounting a broad rise reflecting the dorsal sulcation. Septum truncated at anterior margin of undercut platform. Platform large, about three fifths as long as wide, extending anteriorly about three quarters valve length. Slight indentation at intersection with median septum. Dorsal muscle field and dorsal mantle canal system not preserved.

Statistics

		Ventral Valve		
	N	M	SD	V
L/W	10	0.66	0.04	0.0013
VI/HW	9	0.09	0.02	0.0003
MFL/MFW	10	0.69	0.08	0.0063
MFL/L	10	0.32	0.04	0.0014
		Dorsal Valve		
L/W	12	0.63	0.04	0.0016

Remarks. In general shape this species is most similar to *L. bella* Cooper 1956, *L. incompta* Cooper 1956 and *L. platys* Cooper 1956. It differs from all of these species, however in that its external ornament has more closely spaced accentuated costellae. *L. bella* and *L. incompta* also have considerably shorter undercut platforms. *L. incompta* is also much larger and less strongly sulcate. *L. platys* is much larger, less convex and possesses no sulcus.

The external ornament of *L. sulcata* sp. nov. is perhaps most similar to *L. subcarinata* Cooper 1956 and *L. carinata* Yadrenkina 1965. The former of these two species differs in possessing a smaller ventral muscle field, a considerably shorter undercut platform and in being about twice as large. *L. carinata* Yadrenkina differs in being about three times the size of *L. sulcata* sp. nov., in being very weakly sulcate and in having only a weakly to moderately convex ventral valve and in possessing a much shorter undercut platform.

Leptellina sp.

Plate 13, figs 7-8.

Material. UTGD 120253-55.

Locality. Basal Precipitous Bluff Beds, along Precipitous Bluff track (see Appendix 2).

Diagnosis. Large subquadrate to transversely ovate *Leptellina* with moderately convex ventral valve and moderately concave dorsal valve. Ventral muscle field long, extending anteriorly about two fifths valve length. Dorsal valve with well developed undercut platform extending anteriorly about three quarters valve length, well developed median ridge, short high socket ridges, low, boss-like posteriorly trilobate cardinal process. External ornament unknown.

Remarks. These specimens of *Leptellina* are unusual in having such a long ventral muscle field and a relatively short, narrow undercut platform.

Family ANOPTAMBONITIDAE Rõõmusoks 1963.

Diagnosis. (Emended herein) Subquadrate, concavoconvex to plano convex, multicostellate or unequally parvicostellate. Pseudodeltidium absent or well developed. Chilidium entire. Ventral muscle field short, bilobate, position of adductors unknown. Teeth simple or with weak fossettes. Ventral mantle canal system unknown. Dorsal muscle field obliquely divided into anterior and posterior scars. Socket ridges short, widely divergent, free distally. Cardinal process large, semiconical, excavated anteriorly, ridged posteriorly. Median ridge well developed. Subperipheral rim strong, sometimes developed as diaphragm. Dorsal mantle canal system lemniscate where known.

Remarks. This family was erected by Rõõmusoks to include the genus Anoptambonites. Williams (1965), however, did not adopt this family, preferring to retain the above genus in the Leptellinidae Ulrich & Cooper. Percival (1979, p.94) emended and expanded the family to include forms with alveolate cardinalia, an undercut platform and a median ridge. Thus he assigned the genera Anoptambonites Williams, Chaganella Nikitin, Trimurellina Mitchell, Kassinella Borisyak, Durranella Percival to the family with Xenambonites Cooper listed as "possibly referable".

The genera assigned to the family by Percival fall into two groups. One group, consisting of Anoptambonites and Chaganella, in which the cardinal process is semiconical, rests upon a transverse notothyrial platform and is distinctly separated from the short divergent socket ridges; the other group (Trimurellina, Kassinella, Durranella and Xenambonites) in which the cardinal process is ridgelike and is laterally ankylosed by chilidial plates to the socket ridges. This latter form of cardinalia is characteristic of the Aegiromeninae Havlicek. As a consequence the author would assign Durranella to the Aegiromeninae along with Trimurellina and Kassinella (assigned to the Aegiromeninae by Mitchell (1977) and Williams (1965) respectively) and allow Xenambonites to remain in the Xenambonitinae Cooper.

The type of cardinalia characterising Anoptambonites and Chaganella can also be found in the genus Hesperomena Cooper (see Cooper 1956, Pl. 185A; Ross 1970a, Pl10, fig 1; Norford & Ross 1978, Pl. 2, fig 16.). That the two known species of this latter genus do not have the undercut platform of Anoptambonites and Chaganella again, in the author's opinion, casts serious doubts upon its validity as a criterion for familial classification.

CHAGANELLA Nikitin 1974

Type species. Chaganella chaganensis Nikitin 1974.

Remarks. This genus was diagnosed as having a wedge shaped cardinal process laterally fused with the chilidial plates which are connected to the socket ridges. However, one of the illustrations given by Nikitin (1974, fig. 36) shows a distinct furrow between the cardinal process and the socket ridge. Therefore this genus is better assigned to the Anoptambonitidae (as emended herein) rather than the

Aegiromeninae (assignment of Nikitin, 1974). This genus differs from Anoptambonites in possessing ventrally geniculate margins in the dorsal valve and in having a larger ventral muscle field with divergent triangular diductors.

Chaganella sp.

Plate 13, figs 31-36.

Material. UTGD 99702-8.

Locality. As for Lepidomena fortimuscula.

Diagnosis. Shell up to 17.9 mm wide and 10.0 mm long (dorsal valve). Mean length width ratio of ventral valve 0.63 (variance 0.0043), single dorsal valve just over half as long as wide. Shell concavo- to planoconvex, semi-circular with maximum width usually at hingeline. Ventral valve slightly convex. Dorsal valve slightly concave with ventral geniculation at about 8.0 mm from beak. External ornament unequally multicostellate with slightly accentuated costellae occurring every 0.5 - 0.8 mm with 2 or 3 smaller costellae in between. Ventral interarea about one eighth as high as wide, apsacline or catacline. Dorsal interarea low, planar, anacline.

Teeth strong, supported by very short dental plates. Ventral muscle field strongly bilobate almost as long as wide, extending anteriorly about one third valve length. Vascula media arising from anterolateral margins of diductors diverging anteriorly. Strong roll-like subperipheral rim developed in larger ventral valves.

Cardinal process large, semiconical, alveolate, with median ridge and two lower flanking ridges on posterior surface. Process separated by narrow furrows from widely divergent, short bladelike socket ridges. Undercut platform very well developed, about two thirds as long as wide, extending anteriorly over three quarters valve length (exsag.) with strong median indentation. Median septum strong, narrow, increasing in height anteriorly. Adductors weakly impressed. Anterior pair rounded, adjacent to median septum. Posterior pair ovate elongate anterolaterally, located posterolateral to anterior pair. Dorsal vascular canal system lemniscate.

<u>Statistics</u>.

		Ventral Valve		
	N	M	SD	V
L/W	5	0.63	0.07	0.0043
VI/HW	5	0.12	0.03	0.0010
MFL/MFW	4	0.91	0.09	0.0087
MFL/L	4	0.32	0.03	0.0010

Dorsal Valve

L/W (0.56, 0.50).

Remarks. This series of specimens may be conspecific with *C. chaganensis* as they are both of similar size, shape and external ornament. However, in Nikitin's description of *C. chaganensis* he makes no mention of a ventral subperipheral rim, a feature well developed in the Florentine Valley specimens. The Kazakh species also appears to have well developed ridges laterally bounding the dorsal adductor field, a feature absent from the Tasmanian specimens. Because of these differences and the fact that the number of Tasmanian specimens is at present too small to effectively characterise a species this series of specimens are left under open nomenclature.

Family *SOWERBYELLIDAE* Opik 1930

Subfamily *SOWERBYELLINAE* Opik 1930

SOWERBYELLA (SOWERBYELLA) Jones 1928

Type species. *Leptaena sericea* Sowerby 1839.

Sowerbyella (*Sowerbyella*) cf. *anticipata* Percival 1979

Plate 14, figs 6-12.

Material. UTGD 120233-41.

Locality. Basal Precipitous Bluff Beds, along Precipitous Bluff track (see Appendix 2).

Diagnosis. Large, moderately to strongly concavoconvex _Sowerbyella_ with deeply inset ventral adductors. Dorsal muscle field not thickened, dorsal septa variably developed. Accessory pair of denticles on ventral hingeline with corresponding sockets on dorsal hingeline.

Description. Shell up to 22.0 mm wide and 9.3 mm long. Mean length-width ratio of ventral valve 0.45 (variance 0.0039), dorsal valve similar. Shell moderately to strongly concavoconvex subquadrate to semiovate, with maximum width usually at hingeline. Ventral valve strongly convex with maximum convexity at or slightly anterior to midlength. Lateral slopes flattened. Dorsal valve moderately to strongly concave, concavity fairly even. External ornament uequally parvicostellate with between eight and ten finer costellae separating the coarser costellae from one another. Anteriorly there are from nine to eleven costellae (of all sizes) within one millimetre. Ventral interarea apsacline to orthocline, low. Delthyrial details unknown. Dorsal interarea anacline to catacline, about half height of ventral. No chilidial structures preserved.

Teeth strong, platelike, with well developed shelf-like fossettes. Dental plates absent. Additional articulating tubercle present on hingeline at about one third distance from midwidth to cardinal extremities. Ventral muscle field strongly bilobate, about two thirds as long as wide, extending anteriorly slightly less than two thirds valve length. Adductor scars small, obscure, posteriorly deeply impressed, separated from one another by narrow high median septum which bifurcates at about one quarter valve length to form divergent ridges anteromedially bounding long, rectangular divergent diductor scars. Diductors laterally bounded by well developed ridges extending from sides of delthyrial cavity. Ventral mantle canal system lemniscate.

Cardinal process ridgelike, laterally fused to socket ridges, thus forming semiconical cover over deep alveolus. Socket ridges short, straight, widely divergent. Sockets deep, slitlike. Additional sockets buttressed by short transverse ridge along hingeline at about one third distance from midwidth to cardinal extremities. Median septum variably developed, in some almost absent, in others quite strong, extending anteriorly about two thirds valve length. Submedian septa fairly well developed, thin, same anterior extent as median septum. Dorsal muscle field about seven tenths as long as wide, indistinct, surrounded by weak ridge, extending anteriorly about three quarters valve length. Transmuscle septa variably developed; in some absent, in others stronger and thicker than median or submedian septa.

Statistics.

Ventral Valve

	N	M	SD	V
L/W	5	0.45	0.06	0.0039
MFL/MFW	(0.70, 0.68, 0.67)			
MFL/L	4	0.58	0.10	0.0091

Dorsal Valve

L/W	(0.44, 0.49)
MFL/MFW	(0.73, 0.69, 0.71)
MFL/L	(0.73, 0.72)

Remarks. These specimens differ from those of *S. anticipata* Percival 1979 in being slightly more transverse and more strongly concavoconvex. The specimens described herein have undergone some tectonic deformation. Because of this and the small sample sizes of both *S. anticipata* Percival and the Tasmanian material, little information can be obtained in relation to intraspecific variation. Therefore no definite conclusions as to the assignment of the Tasmanian material can be made.

Sowerbyella (*Sowerbyella*) ?*lepta* Percival 1979.
Plate 13, figs 37-56; Plate 14, figs 1-5.

Material. UTGD 12806-51.

Locality. In northern end of a sliver of Ordovician Limestone (Prion Beach Beds) on western side of Point Cecil (see Appendix 2).

Diagnosis. Medium sized transverse weakly concavoconvex *Sowerbyella* with beaded external ornament with variably spaced accentuated costellae. Ventral muscle field short. Dorsal muscle field short, submedian septa well developed, median septum occasionally present, transmuscle septa absent.

Description. Shell up to 15.2 mm wide and 8.3 mm long. Mean length-width ratio of ventral valve 0.55 (variance 0.0037), dorsal valve 0.52 (variance 0.0061). Shell weakly concavoconvex, semicircular, with maximum width at hinge-line. Cardinal extremities usually slightly alate. Ventral valve slightly, rarely moderately convex with maximum convexity in anterior half. In posterior view, lateral slopes flattened. Dorsal valve weakly concave to nearly planar, sometimes with broad shallow sulcus developed in midportion of valve, disappearing anteriorly. External ornament unequally parvicostellate, accentuated costellae (primary and secondary) spaced from 0.3 to 1.0 millimetres apart at anterior margin, separated from one another by between 2 and 8 finer costellae. Ventral inter-area very low, planar, apsacline. Delthyrium broad, with very small apical pseudodeltidium. Dorsal interarea about half as high as ventral, planar, anacline. Notothyrium with two well developed triangular chilidial plates flanking large cardinal process which occupies entire notothyrium and most of delthyrium.

Teeth platelike, with or without shelf-like fossettes, supported by thick divergent dental plates, the low ridge-like extensions of which laterally bound ventral muscle field. Ventral muscle field strongly bilobed, about three quarters as long as wide, extending anteriorly about two fifths valve length. Diductor lobes ovate to sub-quadrate, separated medially by a well developed narrow ridge which bifurcates anteriorly, the two lower ridges thus formed anteromedially bounding diductor lobes. Adductors small, posteriorly located and deeply impressed. Anterolateral to diductor lobes, subcrescentic concentrically oriented pustulose rises are occasionally developed. Ventral mantle canal system lemniscate, with vascula media broad, extending to anterolateral rises (where present) where they each branch into four smaller canals.

Cardinal process ridgelike, laterally fused to socket ridges, forming semiconical cover over deep alveolus. Socket ridges of moderate length, widely divergent, laterally bounding well developed triangular to subrhombic notothyrial platform. Sockets well developed, slit-like. Median septum only occasionally developed, often replaced by two or more very fine, low, parallel ridges. Submedian septa always well developed, narrow, high anteriorly, extending anteriorly slightly less than half valve length. Dorsal muscle field small, about three quarters as long as wide, extending anteriorly slightly less than half valve length, surrounded by weak ridge. Transmuscle septa not developed. Dorsal mantle canal system lemniscate, with vascula media small, bifurcating anterior of submedian septa. Vascula myaria well developed, separating larger, semicircular to semiovate, posterior adductors from narrowly triangular, anterior adductors, branching into three or four smaller canals a short distance antero-lateral to margin of dorsal muscle field.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	13	0.55	0.06	0.0037
MFL/MFW	6	0.74	0.14	0.0196
MFL/L	6	0.40	0.05	0.0024
		Dorsal Valve		
L/W	14	0.52	0.08	0.0061
MFL/MFW	7	0.74	0.13	0.0179
MFL/L	6	0.48	0.03	0.0008

Remarks. The lack of sufficient documentation of intraspecific variation in the original description of *S.* (*S.*) *lepta* Percival precludes definitive assignment of the specimens described above to this species. *S.* (*S.*) *lepta* is apparently only known from one dorsal interior, two incomplete ventral interiors and one ventral exterior. *S.* (*S.*) cf. *lepta* Percival (1979a, p.109) is also known from very few specimens. With so little data it is impossible to judge the degree of intraspecific variation. Percival (1979a, p.109) in comparing *S.* (*S.*) *lepta* and *S.* (*S.*) cf. *lepta* stated that the latter has "a slightly more accentuated" ornament, "somewhat less divergent" diductor lobes, a relatively larger dorsal muscle field, relatively longer submedian septa, a transverse rather than an elongate alveolus with transverse septa abutting posterolateral ends of submedian septa, not converging anteriorly within submedian septa. In the Tasmanian specimens differences of the magnitude used by Percival to distinguish between his two groups of specimens can only be regarded as intraspecific.

The length of the ventral muscle field given in Percival's descriptions of *S.* (*S.*) *lepta* and *S.* (*S.*) cf. *lepta* is in fact the sagittal length. Measurements taken from the photographs accompanying the original descriptions indicate the exsagittal length of the ventral muscle field to be approximately one third the valve length. This is slightly less than that of the Tasmanian specimens but such differences may be in part due to the smaller size of the New South Wales specimens.

Superfamily STROPHOMENACEA King 1846

Remarks. The classification and the nomenclature adhered to in this section are those of Pope (1976).

Family OEPIKINIDAE Sokolskaya 1960 (as emended by Pope, 1976).

OEPIKINA Salmon 1942

Type species. *Oepikina septata* Salmon 1942.

Oepikina banksi sp. nov.
Plate 14, figs 13-26.

Name. After Dr. M.R. Banks, Geology Dept., University of Tasmania.

Material. Holotype UTGD 99779; Paratypes UTGD 99778, 99780, 99781, 99782, 99783, 99784, 99785, 99786.

Type locality. Same as for *Lepidomena pulchra*.

Diagnosis. Moderately large prolate *Oepikina* without well developed geniculation, with a short ovate ventral muscle field and short widely divergent posterior dorsal septa.

Description. Shell up to 35.0 mm wide (length unknown). Largest whole specimen 29.4 mm wide and 27.5 mm long. Mean length-width ratio of 3 ventral valves 0.89, 3 dorsal valves 0.85. Shell strongly concavoconvex, prolate with maximum width usually between midlength and hingeline. Hingeline just over nine tenths maximum width. Ventral valve moderately convex. Convexity even or slightly stronger anteriorly. Lateral slopes strongly to very weakly flattened. Dorsal valve moderately concave with maximum concavity just anterior to midlength. External ornament unequally parvicostellate with between three and five costellae per millimetre at anteromedial margin, with 1 or 2 smaller costellae between accentuated costellae. Ventral interarea slightly over one tenth as high as wide, planar, orthocline or apsacline. Delthyrium closed by large convex pseudodeltidium. Dorsal interarea approximately one quarter as high as ventral, planar, catacline. Notothyrium covered by large convex chilidium with median drape.

Teeth strong, triangular in section, supported by widely divergent receding dental plates. Ventral muscle field subovate, one specimen having a field over eight tenths as wide as long, extending anteriorly just under one half of valve length. Diductors semiovate, extending beyond but not enclosing posteriorly located, narrowly ovate, adductor scar. Anterior to this a low narrow median ridge separates the two diductor lobes.

Cardinal process bilobed. Lobes large, directed posteriorly. Chilidium with pronounced drape. Mesocardinal ridge absent. Socket ridges, short, high, laterally curving toward hingeline. Sockets large, semiconical. Posterior platform transverse roll-like, with low rounded medial ridge extending to anterior margin of dorsal muscle field. Median dorsal septum, narrow, bladelike, not extending beyond midlength of valve. Anterior dorsal septa very poorly developed or absent. Posterior dorsal septa thick, high anteriorly, widely divergent, extending anteriorly just over one quarter of valve length.

Statistics.

Ventral Valve

	N	M	SD	V
L/W	(0.90, 0.94, 0.84)			
VI/HW	(0.11, 0.14, 0.13)			
MFW/MFL	(0.84)			
MFL/L	(0.46)			
HW/W	6	0.93	0.04	0.0017

Dorsal Valve

L/W	(0.84, 0.85, 0.86)			

Remarks. This species is most similar to *O. expatiata* Cooper 1956. *O. banksi* sp. nov. differs externally, however, in having a distinctly more convex ventral valve. Internally the dorsal valve of *O. banksi* has distinctly shorter, more widely divergent posterior dorsal septa and a more pronounced subperipheral rim. As the ventral interior of *O. expatiata* Cooper remains unknown no comparison can be made. The ventral interior of *O. banksi* is peculiar, however, in that the ventral muscle field is shorter than is common for the genus.

DACTYLOGONIA Ulrich & Cooper 1942

Type species. *Dactylogonia geniculata* Ulrich & Cooper 1942.

Dactylogonia rara sp. nov.

Plate 14, figs 27-29; Plate 15, figs 1-13.

Name. Alludes to the rarity of the species.

Material. Holotype UTGD 99670; Paratypes UTGD 99671, 99672, 99674, 99678, 99679, 99680, 99681, 99682, 99683; Other material UTGD 99673, 99675-7, 99684-5.

Type locality. As for *Lepidomena fortimuscula*.

Diagnosis. Medium sized, moderately geniculate subtrapezoidal *Dactylogonia* with high ventral interarea, widely spaced accentuated costellae, small ventral muscle field and exceptionally high dorsal submedian septa.

Description. Shell up to 11.3 mm wide and 7.3 mm long. Mean length-width ratio of ventral valve 0.72 (variance 0.0089), dorsal valve 0.63 (variance 0.0049). Shell strongly concavoconvex, variably trapeziform with maximum width usually at hingeline. Ventral valve with rounded geniculation occurring from 4 to 6 mm from ventral beak. Posterior to the geniculation valve is weakly convex. Dorsal valve with geniculation occurring from 4 to 5 mm from dorsal umbo. Posterior to the geniculation valve is planar or slightly concave, occasionally with weak posterior sulcus. External ornament unequally parvicostellate with between 8 and 10 costae arising at margin of protegulum and primary costellae arising by intercalation at about 4 mm from umbo. Costae and primary costellae separated from one another by from 6 to 11 very fine, very indistinct radial lirae. Superimposed on the radial ornament is a very fine concentric ornament of fila (about 16 per millimetre). Ventral interarea about one sixth as high as wide, planar or convex, apsacline. Delthyrium completely covered by large strongly convex pseudodeltidium. Foramen large, supra-apical. Dorsal interarea about one quarter as high as ventral, planar anacline or catacline. Notothyrium apparently covered completely by chilidium.

Teeth small, triangular in section, supported by short, thin divergent dental plates. Muscle field small, equidimensional, indistinct, extending anteriorly about one third valve length, bounded laterally by thick ridges arising from dental plates.

Cardinal process bilobate, lobes small with muscle attachment surfaces directed posteriorly. Socket ridges fairly high, bladelike. Sockets semi-conical, underlain by socket pad. Posterior platform poorly developed, strongly transverse. Posterior dorsal septa short, low, thick, occasionally very obscure. Anterior dorsal septa up to half as high as long, concave laterally, extending anteriorly just over half valve length. Median dorsal septum thick, carinate, up to half as high as anterior septa, not extending beyond area bounded by anterior septa. Inside dorsal valve, geniculation is usually not as pronounced anteriorly as it is anterolaterally.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	7	0.72	0.09	0.0089
VI/HW	6	0.16	0.02	0.0006
MFL/MFW	(0.88, 1.08)			
MFL/L	(0.31, 0.35)			
		Dorsal Valve		
L/W	10	0.63	0.07	0.0049

Remarks. *D. rara* sp. nov. is perhaps most similar to *D. concentrica* Cooper 1956 in general appearance but differs in having more closely spaced accentuated costellae, a less abrupt geniculation occurring closer to the ventral beak, and a dorsal valve in which the geniculation is quite pronounced.

The ornament of *D. rara* sp. nov. is most similar to that of *D.* sp. 5 of Cooper (1956, Plate 217 figs 23-36). This unnamed species, although of similar size and shape has a much lower ventral interarea and no geniculation and is believed by Cooper (op. cit.) to be a juvenile form of an as yet undescribed species of *Dactylogonia*.

MACROCOELIA Cooper 1956

Type species. _Macrocoelia obesa_ Cooper 1956

Macrocoelia stenomuscula sp. nov.

Plate 15, figs 14-27.

Name. In reference to the narrow ventral muscle field.

Material. Holotype UTGD 120224; Paratypes UTGD 120193, 120197, 120205, 120206, 120207, 120208, 120212, 120220, 120221, 120232; Other material UTGD 120194-6, 120198-204, 120209-11, 120212-9, 120222-3, 120225-31.

Type locality. Same as for _Skenidioides alatus_.

Diagnosis. Small subquadrate to subcircular, moderately to strongly concavoconvex _Macrocoelia_ with orthocline ventral interarea, apical pseudodeltidium; long, narrow ventral muscle field; long, well developed socket ridges and very poorly developed dorsal septa.

Description. Shell up to 20.6 mm wide and 18.2 mm long. Mean length-width ratio of ventral valve 0.88 (variance 0.0041), dorsal valve 0.80 (variance 0.0037). Shell moderately to strongly concavoconvex, subcircular to subquadrate with maximum width between midlength and hingeline, rarely at hingeline. Hingeline slightly less than nine tenths maximum width. Cardinal extremities narrowly rounded. Ventral valve moderately to strongly convex with convexity even or greatest in anterior half. Valve evenly convex in anterior view. Dorsal valve moderately concave with posteromedial portion planar to slightly concave, lateral and anterior margins strongly concave. External ornament weakly developed and weakly differentiated, with one or two finer costellae separating adjacent accentuated costella. At 5.0 mm from beak there are from 27 to 35 (mode 30) costellae within 5.0 mm. Ventral interarea slightly more than one tenth as high as wide, planar, orthocline. Delthyrium partly covered by narrow convex apically perforate pseudodeltidium. Foramen small, circular. Dorsal interarea very low, planar, anacline or catacline. Notothyrium apparently open.

Teeth large, transversely triangular in section, anteriorly vertically striate. Dental plates very short, thin, divergent. Muscle field ovate, less than nine tenths as wide as long, extending anteriorly about one half valve length. Width slightly more than one third maximum valve width. Diductors narrow, longitudinally semi-ovate, extending well beyond but not enclosing longitudinally ovate median adductors. Adductors bisected by low median ridge which extends to anterior margin of muscle field. Ventral mantle canal system not impressed.

Cardinal process lobes delicate, hemicylindrical with muscle attachment areas concave, vertically striate, facing posterolaterally. Socket ridges long, straight, widely divergent, with low ridges extending posterolaterally from distal end of socket ridges to posterior valve margin. Sockets deep, narrow, semiconical, anterior faces vertically striate. Posterior platform very short, broad, weakly thickened and indistinct. Dorsal median ridge, low, broad, indistinct. Breviseptum very poorly developed or absent. Anterior dorsal septa weakly developed or absent. Posterior dorsal septa absent. Dorsal adductor field not impressed. Subperipheral rim well developed separating planar to convex trail from slightly convex visceral disc. Visceral disc extends anteriorly slightly less than nine tenths valve length. Dorsal mantle canal system not impressed.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	5	0.88	0.06	0.0041
VI/HW	12	0.12	0.03	0.0009
MFW/MFL	7	0.85	0.06	0.0034
MFL/L	(0.54)			
MFW/W	5	0.35	0.04	0.0016
HW/W	25	0.86	0.05	0.0024
		Dorsal Valve		
L/W	13	0.80	0.06	0.0037

Remarks. In external form this species is most similar to *M. elegantula* Cooper 1956. This latter species differs in having a lower ventral interarea, a coarser external ornament and a relatively much wider ventral muscle field. *M. elegantula* is also about twice the size of *M. stenomuscula* sp. nov.

Macrocoelia brownae sp. nov.
Plate 15, fig 28; Plate 16, figs 1-7.

Name. After Dr. Ida Brown who first described in detail Ordovician brachiopods from Tasmania.

Material. Holotype UTGD 120451; Paratypes UTGD 120450, 120452, 120453, 120454.

Type locality. Lower Limestone Member, Benjamin Limestone, Eleven Road Section. (Locality E8 on section C, fig 2.13). G.R. 542785, Sheet 8112, Edition 4, 1979.

Diagnosis. Moderate-sized, subcircular to prolate, moderately concavoconvex *Macrocoelia* with orthocline ventral interarea, apical pseudodeltidium, large subcircular ventral muscle field, short socket ridge, moderately well developed dorsal septa and undifferentiated external ornament.

Description. Shell up to 33.5 mm wide and 30.5 mm long. Length-width ratio of holotype ventral valve 0.97. Mean length width ratio of dorsal valve (N=3) 0.86. Shell moderately concavoconvex, subcircular to longitudinally semiovate, with maximum width at about midlength. Hinge-line about nine tenths of maximum width. Cardinal extremities usually angular, slightly obtuse. Ventral valve moderately and evenly convex. Lateral slopes slightly flattened. Dorsal valve slightly and very evenly concave. External ornament evenly multicostellate with about 22 costellae within 5.0 mm at 5.0 mm from beak. Ventral interarea about one tenth as high as wide, planar, orthocline. Delthyrium partly covered by broad, moderately convex, apical, pseudodeltidium. Dorsal interarea very low, planar, anacline. Notothyrium apparently open.

Teeth large, transversely triangular in section, supported by very short, thick widely divergent dental plates. Muscle field indistinct large, subcircular, extending anteriorly approximately one half valve length. Diductors semicircular weakly radially striate, extending beyond, but not enclosing indistinct lanceolate adductors. Adductors bisected by low median ridge, which anteriorly is capped by a low median carina. Ventral subperipheral rim weak laterally, absent anteriorly. Ventral mantle canal system not impressed.

Cardinal process lobes stout, hemicylindrical with muscle attachment areas concave, facing posteriorly. Socket ridges, short, low, distally curving posteriorly. Sockets broad semiconical. Posterior platform poorly differentiated, very short. Dorsal median ridge very weakly developed, breviseptum occasionally present. Anterior dorsal septa fairly well developed, extending anteriorly to about valve-midlength. Posterior dorsal septa weakly developed, extending anteriorly about one third valve length. Dorsal adductors usually not impressed. Posterior scars large, ovate with long axes directed anterolaterally. Anterior scars not seen. Subperipheral rim well developed, occasionally distinctly undercut.

Statistics.

		Ventral Valve
L/W	0.97	
VI/HW	1.10	
MFL/L	0.54	
HW/W	0.86, 0.92, 0.93	
		Dorsal Valve
L/W	0.83,	0.90, 0.86.

Remarks. This species most closely resembles *M. llandeiloensis* (Davidson) but differs in having a greater length-width ratio and a more narrowly rounded anterior margin.

The dorsal valve of M. llandeiloensis has nearly planar anterior and lateral margins with the greatest concavity being near the umbo. In M. brownae sp. nov. the dorsal concavity is very even. Also in M. brownae, the dorsal subperipheral rim may be undercut, forming a weak diaphragm. M. llandeiloensis also has a better developed ventral subperipheral rim than M. brownae.

This species differs from M. stenomuscula sp. nov. in possessing a less distinct, relatively wider ventral muscle field, a relatively shorter ventral interarea, a broader pseudodeltidium which lacks a foramen, better developed dorsal septa, shorter socket ridges, an undifferentiated external ornament and a greater length-width ratio.

MAAKINA Andreeva 1961

Type species. Oepikina (Maakina) kulinnensis Andreeva 1961

Maakina sp.

Plate 16, figs 8-11.

Material. UTGD 99765-9

Locality. As for Lepidomena fortimuscula sp. nov.

Diagnosis. Prolate to subquadrate *Maakina* with very strongly convex ventral valve, dorsally geniculate about 50 or 60 mm from the beak. Ventral interarea low, planar, apsacline or orthocline. Delthyrium closed by large convex pseudodeltidium, possibly perforate. Dorsal valve moderately concave, geniculate at about 5.0 mm from beak. Dorsal interarea very low, anacline. Notothyrium covered by large convex chilidium. External ornament variable, from equally to unequally multicostellate.

Ventral muscle scar of moderate size. Diductors large flabellate, extending beyond but not enclosing posteriorly located ovate adductors. Dorsal interior represented by juvenile valve only. Cardinal process bilobate, lobes node-like. Socket ridges long, bladelike. Dorsal septa absent except for weak posterior pair.

Statistics.

	Length	Width
Ventral Valve 99765	14.0	16.0
Dorsal Valve 99766	8.4	11.1
Whole specimen 99768	9.0	11.2
Ventral Valve 99769	10.3	12.7

?Oepikinid indet.

Plate 19, figs 5-15.

Material. UTGD 99709-13.

Locality. As for Lepidomena fortimuscula sp. nov.

Diagnosis. Oblate to subquadrate oepikinid with moderately convex ventral valve with high apsacline ventral interarea with large convex pseudodeltidium; ventral subperipheral rim strong. Ventral muscle field unknown. Vascula genitalia strongly impressed, radially ridged. Dorsal valve with well developed bilobate cardinal process, well developed posterior and anterior dorsal septa and weak median septum. Socket and ridges straight, high, blade-like. Vascula genitalia impressed, radially ridged.

Statistics.

		Length	Width
Whole specimen	99709	11.4	14.8
Whole specimen	99710	13.6	15.8
Whole specimen	99711	7.2	9.5
Ventral valve	99712	19.1	-

Remarks. This series of specimens probably belong to a new genus, however, two few specimens are available for sufficient diagnosis. It has the well developed dorsal septation of the Oepikinidae but most other details are obscure, consequently the species is only tentatively assigned to the family.

Family LEPTAENIDAE Hall & Clarke 1894 (as emended by Pope, 1976).

Subfamily MURINELLINAE Pope 1976

Type species. *Murinella partita* Cooper 1956.

Murinella magna sp. nov.
Plate 16, figs 12-21; Plate 17, figs 1-6.

Name. Refers to large size of species.

Material. Holotype UTGD 99787; Paratypes UTGD 99788, 99789, 99790, 99791, 99802, 120244, 120245, 120246, 120250; Other material UTGD 99792-801, 120247-9, 120251-2.

Type locality. Lower Limestone Member, Benjamin Limestone, Eleven Road Section, Florentine Valley (Locality E35 on section B, fig 2.13) G.R. 545781, Sheet 8112, Edition 4, 1979.

Diagnosis. Large geniculate concavoconvex transversely ovate *Murinella* with unequally multicostellate ornament, the accentuated costellae being separated by from 1 to 3 finer costellae.

Description. Shell up to 38.4 mm wide and 28.5 mm long. Mean length-width ratio of ventral valve 0.77 (variance 0.0085), dorsal valve 0.72 (variance 0.0048). Shell strongly concavoconvex, transversely ovate with maximum width at or slightly posterior to midlength. Hinge width just over nine tenths maximum width. Ventral valve strongly convex with maximum convexity anterior to midlength. Geniculation located at about 20 mm anterior to beak. Umbo slightly swollen. Convexity even in anterior view. Dorsal valve moderately concave, with posteromedial portion planar or slightly concave and anterior and lateral margins strongly dorsally geniculate. Geniculation about 15 to 17 mm anterior to beak. External ornament unequally multicostellate with between 4 and 6 costellae. Ventral interarea approximately one eighth as long as wide, planar, orthocline, less commonly anacline or apsacline. Delthyrium covered by large convex pseudodeltidium. Foramen supra-apical, large. Dorsal interarea about one third as high as ventral, planar, anacline or catacline. Notothyrium covered by broad chilidium with well developed drape.

Teeth large, narrowly triangular in section, supported by variably developed, very widely divergent dental plates. Ventral muscle field subcircular to transversely ovate, about four fifths as long as wide extending anteriorly about half valve length, bounded laterally and anterolaterally by low rounded ridges arising from dental plates. Diductors large, semicircular, radially striate, extending beyond but not enclosing narrow, linear, anteriorly raised adductors. Adductors bisected by low rounded anteriorly tapering median ridge which extends well beyond muscle field.

Cardinal process, large, bilobate, lobes as disjunct, ventrally divergent blades with muscle attachment areas directed posteriorly. Socket ridges fairly long, straight, highest at their midlength. Sockets large, deep, semi-conical. Posterior platform short, broad. Dorsal median ridge short, broad, low. Dorsal median septum fine, low extending anteriorly just over half valve length. Anterior dorsal septa low, poorly developed, of similar anterior extent to median septum. Posterior dorsal septa relatively strong, high, extending anteriorly approximately one third valve length. Marginal diaphragm strongly undercut. Visceral disc slightly convex to slightly concave, extending anteriorly about nine tenths valve length.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	10	0.77	0.09	0.0085
VI/HW	8	0.12	0.01	0.0002
MFL/MFW	5	0.78	0.05	0.0022
MFL/L	(0.55, 0.46)			
HW/W	16	0.90	0.05	0.0023
		Dorsal Valve		
L/W	12	0.72	0.07	0.0048

Remarks. In general form this species is perhaps most similar to *M. cancellata* Cooper 1956 and *M. partita* Cooper 1956. It differs from the former species in being over one and a half times as large, in having a more strongly convex ventral valve with the geniculation occurring at a much later stage, and in having accentuated costellae separated by between one and three finer costellae. *M. magna* sp. nov. differs from *M. partita* Cooper in having a strongly concave, geniculate dorsal valve, a relatively much larger ventral muscle field and in being about one and a half times the size of this latter species.

BELLIMURINA Cooper 1956

Type species. Leptaena charlottae Winchell & Schuchert, 1892.

Bellimurina aff. compressa Cooper, 1956

Plate 17, figs 7-16.

Material. UTGD 99686-701, predominantly small specimens or fragments of larger specimens.

Locality. As for Lepidomena fortimuscula.

Diagnosis. Large biconvex Bellimurina with widely spaced accentuated costellae and a short subpentagonal ventral muscle field bounded by strong ridges.

Description. Shell up to 22.6 mm wide and 21.2 mm long. Mean length-width ratio of ventral valve 0.77 (variance 0.0108), dorsal valve 0.73 (variance 0.0085). Shell equally biconvex, subquadrate with maximum width usually at about midlength. Hingeline just over nine tenths maximum width. Ventral valve moderately and evenly convex. Dorsal valve moderately convex with maximum convexity usually in anterior half. External ornament unequally parvicostellate with about 8 costae arising at margin of protegulum. Primary costellae arise at about 5.0 mm from beak. Between accentuated ribs there are from 7 to 12 fine radial lirae. Surface completely rugate with rugae very irregular posteromedially, becoming more regular and concentric anteriorly and laterally. Ventral interarea about one eighth as high as wide, planar apsacline. Delthyrium covered by well developed convex pseudodeltidium. Presence of foramen indeterminate. Dorsal interarea about half as high as ventral, planar, anacline. Notothyrium probably covered by broad, slightly convex chilidium.

Teeth strong, triangular in section, supported by strong, laterally concave dental plates. Ventral muscle field subpentagonal, approximately four fifths as wide as long, extending anteriorly just over one quarter valve length, surrounded completely by strong bounding ridges. Diductors subtriangular, extending beyond but not enclosing triangular adductor scar. Proximal sections of vascula media raised on variably developed subparallel ridges.

Cardinal process bilobate, lobes fairly small, hemi-cylindrical or shaft-like with concave muscle attachment surfaces directed posteroventrally. Socket ridges short, high, bladelike, diverging strongly from hingeline, bounding broad, ill-defined sockets. Posterior platform short, low, roll-like. Posterior dorsal septa short, low and thick. Anterior dorsal septa low, narrow, extending anteriorly about one third valve length. Median dorsal septum narrow, very poorly developed, not extending beyond area bounded by anterior septa.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	4	0.77	0.10	0.0108
VI/HW	4	0.13	0.03	0.0010
MFW/MFL	5	0.85	0.09	0.0084
MFL/L	(0.26, 0.28)			
HW/W	5	0.94	0.05	0.0021
		Dorsal Valve		
L/W	(0.68, 0.84, 0.68)			

Remarks. These specimens are quite similar to *B. compressa* Cooper 1956 in proportions, convexity and external ornament, although in the latter property distinct similarities exist with *B. concentrica* Cooper. This latter species is, however, much more transverse than the specimens in question.

B. compressa Cooper differs from the material described above in attaining only half the size of the latter. As *B. compressa* is only known from exteriors further detailed comparisons cannot be made.

Family STROPHOMENIDAE King 1846 (as emended by Pope, 1976)

Subfamily STROPHOMENINAE King 1846 (as emended by Pope, 1976)

STROPHOMENA Rafinesque in de Blainville 1825

Type species. *Strophomena rugosa* Rafinesque in de Blainville, 1825.

Strophomena burretti sp. nov.
Plate 17, figs 17-27.

Name. After Dr. C.F. Burrett, Geology Department, University of Tasmania.

Material. Holotype UTGD 99997; Paratypes UTGD 99998, 99999, 120101, 120121, 120124, 120126, 120128, 120130, 120131, 120151, 120154, 120162, 120173; Other material UTGD 99994-6, 120102-20, 120122-3, 120124, 120127, 120129, 120132-50, 120152-3, 120155-61, 120163-72, 120174-5.

Type locality. Lower Limestone Member, Benjamin Limestone, 2 metres below Lords Siltstone Member on top of small hill along southern branch of Sixteen Road. (Locality 6 on section F, fig 2.9). G.R. 561854 Sheet 8112, Edition 4, 1979.

Diagnosis. Small, moderately resupinate, subquadrate *Strophomena* usually with small alate cardinal extremities, a short subcircular ventral muscle field, well developed rounded ventral subperipheral rim with beading indistinct, long widely divergent socket ridges, short dorsal median ridge, two well developed laterally convex adventitious septa.

Description. Shell up to 18.8 mm wide and 14.4 mm long. Mean length-width ratio of ventral valve 0.78 (variance 0.0025), dorsal valve 0.79 (variance 0.0029). Shell moderately resupinate, subquadrate with maximum width usually at hingeline. Posterior portion of lateral margins variably concave giving rise to small alate cardinal extremities. Ventral valve posteriorly weakly convex, anteriorly and anterolaterally weakly concave. Dorsal valve moderately convex, with maximum convexity in anterior half, posterior half nearly planar. External ornament variably unequally parvicostellate with accentuated costellae separated by between one and five smaller costellae at the anterior margin. At 5.0 mm from beak, there are from 28 to 36 (mode 33) costellae within 5.0 mm. Costellae crossed by very fine concentric fila (about 15 per millimetre). Ventral interarea about one tenth as high as wide, planar, apsacline. Delthyrium covered by broad moderately convex apically perforate pseudodeltidium. Forament small, circular. Dorsal interarea about one third as high as ventral, planar, anacline. Notothyrium covered by broad, convex chilidium with distinct drape.

Teeth strong, triangular in section supported by short, stout, strongly divergent dental plates. Muscle field fairly small, subcircular, slightly more than nine tenths as long as wide, extending anteriorly nearly two fifths valve length. Diductors more or less semicircular, bounded anteriorly and laterally by strong ridges extending from dental plates, extending beyond but not enclosing narrow ovate median adductors. Adductors bisected by well developed median ridge which usually extends to anterior end of muscle field. Subperipheral rim strongly developed, rounded, beading indistinct. Visceral disc planar to slightly convex. Ventral mantle canal system indistinct.

Cardinal process delicately bilobate, with muscle attachment areas directed posteroventrally. Mesocardinal ridge only developed posteriorly, ankylosed to prominent drape of chilidium. Socket ridges strong, widely divergent, with slightly posteriorly curved lateral extremities. Ridges occupy nearly two fifths maximum valve width. Sockets deep, semiconical, nonstriate. Posterior platform indistinct, broad, triangular, very short. Dorsal median ridge low, rounded, bifurcating anteriorly at about one quarter valve length, consequent parallel ridges weak, occasionally extending anteriorly two thirds valve length.

Breviseptum usually weakly developed, occasionally absent. One pair of adventitious septa commonly well developed, convex laterally. Posterior dorsal septa very weakly developed or absent. Adductor field transverse, indistinct. Mantle canal system saccate. Vascula genitalia reniform, located posterolaterally, radially pitted. Vascula media indistinct. Vascula myaria indistinct bounded medially by adventitious septa.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	32	0.78	0.05	0.0025
VI/HW	21	0.10	0.01	0.0002
MFL/MFW	37	0.93	0.08	0.0059
MFL/L	33	0.39	0.04	0.0015
		Dorsal Valve		
L/W	20	0.79	0.05	0.0029

Remarks. This species of Strophomena is most similar to S. oklahomensis Cooper 1956. S. burretti sp. nov. differs, however, in having a less convex dorsal valve without a sulcus and with its maximum convexity being in the anterior rather than posterior half, in possessing small alate extensions at its cardinal extremities and in having more strongly developed muscle bounding ridges.

Strophomena cf. *oklahomensis* Cooper 1956

Plate 17, figs 28-30; Plate 18, figs 1-5.

Material. UTGD 99969-93.

Locality. Lower Limestone Member, Benjamin Limestone 100 metres Southwest of Sixteen Road (Locality 2 on section E, fig 2.9) G.R. 562856 Sheet 8112, Edition 4, 1979.

Diagnosis. Small to medium sized, moderately to strongly resupinate, subquadrate, *Strophomena* with a short subcircular to rounded subtriangular ventral muscle field, a weak subperipheral rim only developed in gerontic specimens, long, widely divergent socket ridges and a posteriorly sulcate dorsal valve.

Description. Shell up to 23.8 mm wide and 16.7 mm long. Mean length-width ratio of ventral valve 0.77 (variance 0.0020), dorsal valve 0.73 (variance 0.0055). Shell moderately to strongly resupinate, subquadrate with maximum width just anterior to hingeline. Hingeline slightly over nine tenths maximum width. Some specimens with small rounded alate cardinal extremities. Ventral valve posteriorly concave. Dorsal valve moderately to strongly convex with maximum convexity at about midlength, commonly posteriorly sulcate. External ornament variable, from fairly equally parvicostellate to unequally so, with accentuated costellae separated by between 1 and 3 smaller costellae. Within 5 mm at 5 mm from the beak there are from 24 to 31 (mode 30) costellae of all sizes. Costellae crossed by very fine fila in some specimens. Ventral interarea about one tenth as high as wide, planar, apsacline (nearly catacline). Delthyrium covered by broad, strongly convex, apically perforate pseudodeltidium. Foramen of moderate size, circular. Dorsal interarea about one third as high as ventral, planar, anacline (nearly orthocline). Notothyrium covered by broad convex chilidium.

Teeth strong, triangular in section supported by short, thin, strongly divergent dental plates. Muscle field comparatively small, subcircular to rounded subtriangular, over nine tenths as long as wide extending anteriorly nearly four tenths valve length. Diductors semicircular to rounded narrowly triangular, bounded laterally by well developed ridges extending from dental plates. Bounding ridges weak to absent anteriorly, and in some specimens absent anterolaterally. Median adductor field obscure, probably long, ovate, bisected by well developed median ridge which extends to anterior end of muscle field. Subperipheral rim not developed in most specimens, weakly developed in some gerontic specimens. Ventral mantle canal system not impressed.

Cardinal process delicately bilobate, with muscle attachment surfaces directed posteroventrally. Mesocardinal ridge not observed, chilidium with well developed drape. Socket ridges strong, widely divergent with slightly posteriorly curved lateral extremities, occupying nearly two fifths maximum valve width. Sockets of variable depth, semiconical, nonstriate. Posterior platform indistinct, broad, short triangular. Dorsal median ridge very low, rounded extending anteriorly about one quarter valve length, in some specimens bifurcating anteriorly. Breviseptum usually weakly developed, occasionally absent. One pair of adventitious septa occasionally weakly developed, usually absent. Dorsal adductor field and mantle canal system indistinct.

<u>Statistics</u>.

		Ventral Valve		
	N	M	SD	V
L/W	11	0.77	0.05	0.0020
MFL/MFW	12	0.95	0.08	0.0063
MFL/L	12	0.37	0.02	0.0005
HW/W	18	0.93	0.04	0.0013
		Dorsal Valve		
L/W	10	0.73	0.07	0.0055

Remarks. These specimens seem very similar to *S. oklahomensis* Cooper 1956 but they do differ in minor details. The Tasmanian specimens have no subperipheral rim (except in gerontic specimens) whereas a subperipheral rim is commonly found in *S. oklahomensis*. The former also commonly have weakly developed, rounded alate cardinal extremities whereas *S. oklahomensis* has convex or straight lateral margins. These features are not worth formal recognition but because the dorsal interior of *S. oklahomensis* is unknown a definite assignment of the specimens in question cannot be made.

?*Strophomena* sp.

Plate 18, figs 9-10.

Material. UTGD 99770-7

Locality. As for *Lepidomena fortimuscula*.

Diagnosis. Large gently convexoconcave or resupinate strophomenid with a slightly to moderately concave ventral valve with low apsacline interarea. Delthyrium partly closed by a short, strongly convex pseudodeltidium. External ornament finely and unequally parvicostellate. Ventral muscle field large, flabellate, bounded by strong ridges. Adductors narrow subovate, located posteriorly. Cardinal process bilobate, lobes hemicylindrical with muscle attachment areas directed posteroventrally. Socket ridges short, blade-like with triangular supports directed postero-dorsally underlying socket.

Statistics.

	L	W
Ventral Valve 99770	23.0 mm	44.6 mm
Dorsal Valve 99771	22.0 mm	40.0 mm
Ventral Valve 99774	29.5 mm	48.0 mm

Remarks. This species is only represented by a few fragmented valves. Until more details relating to the ventral muscle field can be obtained, it is not possible to assign this species with certainty to a genus.

Subfamily FURCITELLINAE Williams 1965 (as emended by Pope, 1976)

HOLTEDAHLINA Foerste 1924

Type species. *Leptaena sulcata* de Verneuil 1848.

Remarks. *Holtedahlina* was erected by Foerste (1924) for strophomenids having a biconvex shell with a dorsal fold, ventral sulcus and a coarse, fairly evenly costellate external ornament. Cooper (1956a) in erecting the genus *Furcitella* differentiated it from *Holtedahlina* on the presence in the former of a bifurcation of the dorsal median ridge. He noted that the median ridge of Holtedahlina did not bifurcate but that two ridges arose on either side of the median ridge. Nikiforova and Andreeva (1961) and Williams (1962) questioned the validity of this as a criterion of generic distinction. Indeed, Nikiforova and Andreeva noted that the median ridge of Strophomena is sometimes bifid and suggested that because of this and the variability in valve convexity that Holtedahlina should be regarded as a subgenus of Strophomena. Pope (1976) in studying the shell structure of the strophomenides noted that Strophomena had no true dorsal septa, only adventitious septa and that Holtedahlina Foerste and Furcitella Cooper had true dorsal septa. Further, he noted the only differences between Holtedahlina and Furcitella were the stronger dorsal ridges of the latter and the fold of the former.

The species referred to below has a narrow dorsal sulcus, moderately well developed anterior dorsal septa and less well developed posterior dorsal septa. Such a combination of features precludes assignment to either Furcitella or Holtedahlina as presently understood. A more probable solution is that intimated by Pope (1976 p.153), that is, Furcitella and Holtedahlina are congeneric.

Holtedahlina sp.

Plate 18, figs 6-8.

Material. UTGD 120176-92.

Locality. As for Ptychopleurella cf. magna.

Diagnosis. Large ventribiconvex, transverse, subquadrate to subovate dorsally sulcate Holtedahlina with coarse variably unequally parvicostellate, a short nearly equidimensional ventral muscle field, short high socket ridges, well developed anterior dorsal septa, weaker posterior dorsal septa. Breviseptum and dorsal median ridge weak.

Description. Shell up to 23.0 mm wide and 15.7 mm long. Mean length-width ratio of ventral valve 0.70 (variance 0.0021), dorsal valve about 0.63. Shell slightly ventribiconvex, subquadrate to subovate with maximum width at, or posterior to midlength. Hingeline approximately nine tenths maximum width. Ventral valve moderately to slightly convex with maximum convexity in posterior half. Weak fold present. Dorsal valve slightly convex with maximum convexity in anterior half. Weak to moderately well developed narrow sulcus present. External ornament variable, from nearly equally, to quite unequally parvicostellate, with accentuated costellae separated from one another by between 1 and 5 smaller costellae. Within 5 mm at 5 mm from the beak, there are from 18 to 23 costellae of all sizes. Ventral interarea less than one fifth as high as wide, planar, apsacline. Delthyrium covered by large convex apically perforate pseudodeltidium. Foramen large, circular. Dorsal interarea, very low, planar, anacline. Notothyrium covered by large convex chilidium.

Teeth strong, triangular, supported by short thin divergent dental plates. Muscle field small, subovate, equidimensional. Diductors semicircular to rounded subtriangular, extending beyond but not enclosing obscure median adductor scars. Adductors bisected by low, narrow, median ridge. Ventral mantle canal system not impressed.

Cardinal process consisting of two parallel blades with muscle attachment areas directed posteriorly to posterodorsally. Mesocardinal ridge very strong, high posteriorly, ankylosed to prominent drape of chilidium. Socket ridges short, high, straight, diverging strongly from hingeline, occupying slightly less than one third shell width. Sockets deep, broad, semiconical, nonstriate. Posterior platform short, fairly narrow, indistinct. Dorsal median ridge very weakly developed, bifurcating anteriorly in some specimens. Breviseptum weakly developed, extending anteriorly about half valve length. Anterior dorsal septa well developed, extending anteriorly about half valve length. Posterior dorsal septa well developed, extending anteriorly about half valve length. Posterior dorsal septa short, anteriorly strongly thickened and high. Occasionally a low thickening extends posterolaterally from anterior ends of posterior septa. Dorsal adductor field transversely ovate. Posterior scars narrowly ovate. Anterior scars not visible. Dorsal mantle canal system not impressed.

Statistics.

	Ventral Valve			
	N	M	SD	V
L/W	5	0.70	0.05	0.0021
MFW/MFL	5	0.95	0.12	0.0138
MFL/L	(0.41)			
HW/W	7	0.90	0.06	0.0033
	Dorsal Valve			
L/W	(0.62, 0.63, 0.65)			

Remarks. These specimens are assigned to Holtedahlina on the basis of their fairly coarse costellation, their biconvex form, their strongly backwardly curved bladelike cardinal process lobes and the development of dorsal septa. This species is however peculiar in that it has a sulcate anterior commissure. Unfortunately the material available will not allow an adequate description of the species to be made. It is therefore left under open nomenclature.

Tribe TERATELASMINI Pope 1976

TERATELASMELLA gen. nov.

Name. Similar to Teratelasma.

Type species. *Teratelasmella plicata* sp. nov.

Diagnosis. Like *Teratelasma* but parvicostellate with poorly developed anterior dorsal septa, an exceptionally high dorsal median septum, a short well developed ventral median septum and a strongly plicate anterior commissure.

Teratelasmella plicata sp. nov.
Plate 18, figs 11-40; Plate 19, figs 1-4.

Name. Refers to strongly plicate anterior commissure.

Material. Holotype UTGD 99641; Paratypes UTGD 99640; 99642, 99644, 99645, 99647, 99648, 99649, 99664, 99667, 99668, 99669; Other material UTGD 99643, 99646, 99650-63, 99665-6.

Type locality. As for *Lepidomena fortimuscula*.

Diagnosis. See generic diagnosis.

Description. Shell up to 11.5 mm wide and 8.8 mm long. Mean length-width ratio of ventral valve 0.77 (variance 0.0045), dorsal valve 0.67 (variance 0.0024). Shell biconvex, subquadrate to semicircular with maximum width just anterior to hingeline. Hinge width about nine tenths maximum width. Ventral valve slightly convex with maximum convexity in posterior half. Lateral slopes flattened slightly. Anteriorly valve is strongly sulcate, sulcus rounded. Dorsal valve slightly convex, posterior half of valve planar, anterolateral portions of valve deflected ventrally, bounding strong rounded fold. Ventral interarea less than one fifth as high as wide, planar, apsacline. Delthyrium covered by well developed, strongly convex pseudodeltidium. Dorsal interarea less than half as high as ventral, planar, anacline (tending to catacline). Notothyrium bounded laterally by two disjunct chilidial plates. External ornament parvicostellate, weakly impressed with between 12 and 16 costellae within 5.0 mm at 5.0 mm from beak. Radial ornament often largely obscured by concentric growth lamellae.

Teeth large, triangular in section, supported by short, stout, widely divergent dental plates. Muscle field short, cordate, nearly equidimensional, extending anteriorly about two fifths valve length, laterally bounded by variably developed ridges extending from dental plates. Diductors tear-shaped to subtriangular, extending beyond but not enclosing linear adductors. Adductors bisected by well developed median ridge which does not extend far beyond muscle field.

Cardinal process bilobate, occupying short roll-like posterior platform. Lobes small hemicylindrical with muscle attachment surfaces directed posterolaterally. Socket ridges curved, nearly parallel to hingeline, enclosing semi-ellipsoidal sockets. Adductor scars impressed on low triangular to transversely ovate platform which extends anteriorly less than one half valve length. Posterior scars rounded, impressed directly anterior to cardinal process lobes. Anterior scars larger, subquadrate to circular. Anterior dorsal septa low, thick. Median septum thin, extremely high, nearly extending to anterior margin of valve.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	16	0.77	0.07	0.0045
VI/HW	18	0.18	0.03	0.0008
MFL/MFW	12	0.99	0.11	0.0119
MFL/L	10	0.38	0.05	0.0022
HW/W	24	0.89	0.04	0.0016
		Dorsal Valve		
L/W	14	0.67	0.05	0.0024

Order PENTAMERIDA Schuchert & Cooper 1931.

Suborder SYNTROPHIIDINA Ulrich & Cooper 1936.

Superfamily PORAMBONITACEA Davidson 1853.

Family PARASTROPHINIDAE Ulrich & Cooper 1938.

Subfamily ANASTROPHIINAE Nikiforova 1960.

MAYDENELLA gen. nov.

Name. From the town of Maydena, southern Tasmania.

Type species. *Maydenella asymmetrica* sp. nov.

Diagnosis. Transversely ovate, subequally biconvex, surface entirely costate. Ventral interarea low, narrow, apsacline. Delthyrium open. Dorsal interarea absent. Spondylium posteriorly sessile, supported anteriorly by short median septum. Brachiophores short, thick. Alate plates short. Brachiophore plates long subparallel forming long sessile, flat bottomed septalium.

Remarks. This genus is most similar to *Eoanastrophia* Nikiforova & Sapelnikov 1973 but differs in having the brachiophore plates parallel, bounding a long, flat bottomed sessile septalium. *Eoanastrophia* has the two brachiophore plates converging and merging into a low thick septum (Sapelnikov & Rukavishnikova 1975 p. 34).

Maydenella asymmetrica sp. nov.

Plate 19, figs 16-36.

Name. Refers to commonly asymmetric nature of commissure.

Material. Holotype UTGD 99748; Paratypes UTGD 99721, 99730, 99732, 99733, 99735, 99737, 99739, 99749, 99754, 99755, 99762; Other material UTGD 99722-9, 99731, 99734, 99736, 99738, 99740-7, 99750-3, 99756-61. 99763-4.

Type locality. As for *Lepidomena fortimuscula*.

Diagnosis. See generic diagnosis.

Description. Shell up to 12.2 mm wide and 9.8 mm long. Mean length-width ratio of ventral valve 0.85 (variance 0.0016), dorsal valve 0.84 (variance 0.0024). Shell subequally biconvex, globose, transversely subovate with maximum width at, or slightly anterior to midlength. Hinge width variable, slightly over two fifths maximum width. Ventral valve moderately convex with maximum convexity in posterior half. Dorsal valve strongly and evenly convex, nearly semicircular in lateral view. Anterior commissure uniplicate to asymmetrical. External ornament costate. Costae angular with primary costae arising at margin of protegulum. Secondary costae arise by intercalation at a distance of from 1 to 2 mm from beak.

At a distance of 5.0 mm from the beak, between 7 and 10 (mode 8) costae occur within 5.0 mm. Ventral interarea variable in height, about one quarter as high as wide, concave apsacline. Delthyrium open. Dorsal interarea absent.

Teeth strong, curved supported by strong dental plates uniting to form a deep narrow, u-shaped, posteriorly sessile spondylium. Spondylium extends anteriorly slightly less than two fifths valve length, raised anteriorly on short median septum. Muscle impressions not visible.

Cardinal process absent. Brachiophores rod-like bounding long narrow sockets underlain by well developed fulcral plates. Brachiophore plates subparallel forming a flat-floored sessile septalium which extends anteriorly slightly less than one third of valve length. Alate plates well developed, extending anteriolateral of brachiophore plates. Dorsal muscle field usually impressed, laterally bounded by low, narrow, ridges. Field approximately two thirds as wide as long extending anteriorly slightly less than one half valve length. Posterior adductors longitudinally ovate, located adjacent to anterior portion of septalium. Anterior adductors larger, subtriangular, located adjacent to weak narrow median ridge which extends anterior of septalium.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	16	0.85	0.04	0.0016
MFL/L	6	0.38	0.03	0.0010
VI/HW	14	0.24	0.06	0.0031
HW/W	20	0.43	0.06	0.0041
		Dorsal Valve		
L/W	19	0.84	0.05	0.0024
MFW/MFL	9	0.69	0.06	0.0038
MFL/L	8	0.48	0.05	0.0021

Order RHYNCHONELLIDA Kuhn 1949

Superfamily RHYNCHONELLACEA Gray 1848

Family RHYNCHOTREMATIDAE Schuchert 1913

Diagnosis. Sulcus and fold well developed, costae strong, angular to subangular, beginning at apex. Hingeplate divided, cemented to median septum by callus, with or without septiform cardinal process. Pedicle scar occupies entire delthyrial cavity. Muscle field large, flabellate, diductors surrounding median adductors (emended from Amsden, 1978).

Remarks. The subfamily Rhynchotreminae was originally erected by Schuchert (1913) to include rhynchonellids with a cardinal process. Cooper (1956a) in raising the group to family level included within it "Rhynchonellacea with rudimentary deltidial plates and well formed dental plates in the pedicle valve; brachial valve provided with a small cruralium, with or without a cardinal process, long crural processes, cruralium without covering plates.....". To this family he assigned the genera Rhynchotrema Hall and Rostricellula Ulrich & Cooper, whilst the genus Lepidocyclus Wang was assigned to a new family Lepidocyclidae Cooper. This family was diagnosed as having "concave deltidial plates (?) in the pedicle valve and a cardinal process in the brachial valve".

Schmidt & McLaren (1965) included in the family Rhynchotrematidae, genera with a well developed sulcus and fold, strong costae beginning at apex, concentric lamellae or striae and with concave hinge-plates separated by a notothyrial cavity containing a septiform cardinal process. This family was subdivided into the subfamilies Rhynchotrematinae with well developed dental plates and "notothyrial cavity formed by welding of hinge plates with median septum or ridge or callosity" (p. H554) and Orthorhynchulinae with reduced dental plates and a "pair of crural plates starting from the inner edges of hinge plates and extending dorsally" (p. H556-7) occasionally obscured by callosity. The former subfamily included the genera *Rhynchotrema*, *Ferganella*, *Hypsiptycha*, *Lepidocyclus*, *Stegerhynchus*, *Stegorhynchella* and possibly *Pleurocornu* whilst the latter subfamily included *Orthorhynchula*, *Callipleura*, *Latonotoechia*, *Machaeraria*, *Orthorhynchuloides*, *Sicorhyncha* and *Zlichorhynchus*.

The genera *Rostricellula* and *Lepidocycloides* were tentatively assigned to the family Trigonirhynchiidae McLaren.

Howe (1965c) followed Cooper's (1956) classification, but differentiated the Rhynchotrematidae from the Lepidocyclidae on the basis of the latter having a long curved tubular pedicle cavity, with dental plates partially to completely obscured by adventitious deposits, and the former having a large delthyrial cavity with rudimentary to well formed dental plates.

Rozman (1969, p. 369) erected the subfamily Rostricellulinae and differentiated its members from those of the Rhynchotrematinae by their having a tuberculate concentric microsculpture and lacking a cardinal process. Rozman included the genera Rostricellula, Evenkorhynchia Rozman and Lepidocycloides in the Rostricellulinae.

Amsden (1978) divided the Rhynchotrematidae into the two subfamilies. Rhynchotrematinae and Lepidocyclinae with the former being characterised by a thin posterior ventral shell wall, shallow muscle scars and by the presence of dental plates. The latter subfamily was characterised by a thick posterior ventral shell wall, impressed muscle scars and obscure dental plates.

Amsden (op. cit.) also disagreed with lowering of the Orthorhynchulidae Cooper to a subfamily of the Rhynchotrematidae (Schmidt & McLaren, 1965).

The author generally agrees with the taxonomic scheme proposed by Amsden but believes more emphasis should be placed on the style of musculature present when considering a higher classification of rhynchonellide genera. Such considerations are incorporated in the revised diagnoses of the higher taxa presented herein.

Subfamily RHYNCHOTREMATINAE Schuchert 1913

Diagnosis. Ventral valve with thin posterior shell wall, shallow muscle scars, and distinct dental plates. Delthyrium with or without deltidial plates. Dorsal valve with low median septum, with or without septiform cardinal process (emended from Amsden, 1978).

RHYNCHOTREMA Hall 1860.

Type species. *Atrypa increbescens* Hall 1847.

Diagnosis. Small to moderate size, rounded triangular to transversely elliptical; delthyrium narrow, with or without rudimentary deltidial plates. Dental plates short, umbonal cavities small, teeth with large fossettes. Dorsal median septum low, extending to middle of valve; notothyrial cavity short, deep, usually with septiform cardinal process (emended from Schmidt & McLaren 1965).

Remarks. In recent years there has been considerable confusion over the differentiation of the genera *Rhynchotrema* and *Rostricellula*. Howe (1965c, p. 1126-7) noted that "although the cardinal process and surface ornamentation are normally valid criteria for separating these two genera", there were exceptions. He listed three such exceptions, the first being that serial sections of Rostricellula acutiplicata Cooper reveal a well developed cardinal process. Secondly he states "a few specimens of Rostricellula exhibit imbricate ornamentation (Cooper 1956 pl. 133F, figs 36-41)". Howe neglects to mention that the imbricate species illustrated by Cooper also belong to Rostricellula acutiplicata. Cooper 1956 p. 630) in his description of this species states that the exterior is "finely filate and papillose". Thus Rostricellula acutiplicata possesses all three of the diagnostic features of both Rhynchotrema and Rostricellula. Howe's third example is that of Rhynchotrema dentatum (Hall) which possesses a well developed cardinal process but never exhibits imbricate ornamentation.

The usefulness of these criteria for generic differentation is very limited. As a further example, Rhynchotrema crossi sp. nov. (see below) has a low ridge-like cardinal process whilst externally some specimens have a finely pustulose microornament due to the intersection of fine concentric fila and radial lirae. Other specimens of R. crossi however only exhibit the concentric fila whilst further specimens have no discernible microornament at all. Imbricate ornamentation only occurs in occasional specimens.

The diagnostic property of the genus _Rostricellula_ is its high, narrow, V-shaped Trigonirhynchioid septalium. Inside _Rhynchotrema_ however, the medial ridge is lower and is joined to the posterior part of the underside of the hingeplates by deposits of callus. This gives rise to a short, broad, deep, notothyrial cavity. The development of the cardinal process in _Rhynchotrema_ has been shown by Howe (1979) to be highly variable, even within a single species.

Rhynchotrema _bailliei_ sp. nov.

Plate 19, Figs 37-40; Plate 20, figs 1-11.

Name. After Mr. P.W. Baillie of the Tasmanian Geological Survey.

Material. Holotype UTGD 120455; Paratypes UTGD 120456, 120457, 120458, 120460, 120465, 120466, 120468, 120469, 120471, 120481, 120490; Other material UTGD 120459, 120461-4, 120467, 120470, 120472-80, 120482-9, 120491-500.

Type locality. As for _Lepidomena_ _fortimuscula_.

Diagnosis. Small to medium size, strongly ventrally sulcate, globular _Rhynchotrema_. Costae angular with 3 in the sulcus and between 6 and 8 on the flanks. Dental plates weakly developed. Dorsal median septum low. Cardinal process absent or as low ridge.

Description. Shell up to 10.8 mm wide and 8.8 mm long. Mean length-width ratio of specimens over 7.0 mm wide is 0.89 (variance 0.0032) for the ventral valve and 0.82 (variance 0.0024) for the dorsal valve. Shell strongly biconvex, transversely ovate with maximum width at about midlength. Ventral valve moderately convex, with middle of valve flattened, greatest convexity at umbo and near anterior margin. Valve fairly evenly convex in posterior view. Sulcus arises at about 4.0 mm from beak, deepening rapidly forming angular trapeziform tongue. Dorsal valve strongly convex in profile, in posterior view exhibiting high well developed, flattened fold and convex flanks. External ornament consisting of strong angular costae, of which three (less commonly two or four) occur in sulcus, with between 6 and 8 (rarely 5) occurring on the flanks. Concentric growth lamellae absent or occasionally developed near anterior margin. Ventral beak suberect to nearly straight, partially obscuring dorsal beak. Delthyrium broad, bounded laterally by rudimentary deltidial plates.

Teeth of moderate size, knob-like, slightly curved, supported by thin slightly receding dental plates which separate semiconical umbonal cavities from the broad conical delthyrial cavity. Pedicle scar occupies entire delthyrial cavity, with anterior margin slightly raised. Muscle field obscure.

Hingeplates narrowly triangular slightly concave, widely divergent with very fine crura curving slightly ventrally from their anterior extremities. Outer socket ridge weak, inner socket ridge very high. Dorsal median septum low, triangular in section obscured by callus posteriorly forming a short, low, broad notothyrial platform which only rarely possesses a low ridgelike cardinal process. Dorsal muscle field obscure.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	15	0.89	0.06	0.0032
		Dorsal Valve		
L/W	14	0.82	0.49	0.0024

Remarks. This species of Rhynchotrema is distinguished by its considerable thickness and its deep ventral sulcus. The species most closely approaching R. bailliei in these features is R. wisconsinense Fenton & Fenton. This latter species, however, possesses a large ventrally expanding cardinal process between two broad, robust hingeplates whereas R. bailliei has delicate hingeplates and usually lacks a cardinal process. R. wisconsinense is also considerably larger.

Rhynchotrema ponderosa sp. nov.

Plate 20, figs 12-39.

Name. Alludes to ponderous nature of dorsal cardinalia.

Material. Holotype UTGD 120501; Paratypes UTGD 120502, 120503, 120504, 120505, 120506, 120507, 120508, 120509, 120510, 120511, 120512, 120513, 120514.

Type locality. As for *Tasmanorthis calveri*.

Diagnosis. Medium to large, moderately to weakly sulcate *Rhynchotrema*. Costae angular to slightly rounded with 2 or 3 in the sulcus and from 5 to 7 on the flanks. Dental plates thin, umbonal cavities small. Cardinal process usually present as very low ridge.

Description. Shell up to 16.1 mm wide and 13.9 mm long. Mean length-width ratio of specimens over 9.0 mm wide is 0.90 (variance 0.0004) for ventral valve and 0.81 (variance 0.0013) for the dorsal valve. Shell strongly biconvex, subcircular to transversely ovate with maximum width slightly anterior to midlength. Ventral valve moderately convex with maximum convexity in posterior half. In posterior view, lateral slopes are slightly flattened. Sulcus arising at about 5 mm from beak, deepening slowly, forming fairly short rounded trapeziform tongue. Dorsal valve strongly and fairly evenly convex, in posterior view with slightly flattened lateral slopes and obscure fold. External ornament consisting of strong angular to slightly rounded costae of which 3 (less commonly 2) occur in the sulcus with between 5 and 7 on the flanks. Extremely fine concentric growth lines occur on some specimens. Ventral beak suberect, partially obscuring dorsal beak. Delthyrium broad, bounded laterally by rudimentary deltidial plates.

Teeth large, ovate in section, with pit-like fossettes, supported by thin, slightly receding dental plates which separate very narrow umbonal cavities from the broad delthyrial cavity. Pedicle scar occupies entire delthyrial cavity. Ventral muscle field subflabellate, trapeziform, extending to about midlength of valve. Adductors indistinct, surrounded by diductors. Hingeplates usually quite massive, narrowly triangular, variably concave, divergent, with strong crura curving strongly ventrally from their anterior extremities. Outer socket ridge weak, inner socket ridge variable in height. Dorsal median septum short, low, rounded to angular, obscured by callus posteriorly. This, along with the variable amount of callus supporting the hinge plates forms a short, deep notothyrial cavity of varying width. A low thin ridge-like cardinal process usually occupies the notothyrial cavity. Dorsal muscle field subquadrate, divided medially by dorsal septum. Individual scars difficult to distinguish.

Statistics.

		Ventral Valve		
	N	M	SD	V
L/W	5	$\boxed{0.90}$	0.02	0.0004
		Dorsal Valve		
L/W	10	0.81	0.04	0.0013

Remarks. This species of *Rhynchotrema* is distinguished by its great thickness and its poorly developed ventral sulcus. In its thickness it can be likened to *R. wisconsinense* Fenton & Fenton but *R. ponderosa* sp. nov. lacks the strongly developed sulcus, the high cardinal process and the well developed concentric growth lamellae of the former.

Rhynchotrema crossi sp. nov.

Plate 20, figs 40-44; Plate 21, figs 1-22.

Name. After Mr G. Cross of Australian Newsprint Mills Pty Ltd.

Material. Holotype UTGD 120554; Paratypes UTGD 120544, 120545, 120546, 120547, 120550, 120552, 120553, 120556, 120557, 120560, 120561; Other material UTGD 120548-9, 120551, 120555, 120558-9, 120562-3.

Type locality. As for *Skenidioides alatus*.

Diagnosis. Medium to large, moderately ventrally sulcate, subtriangular *Rhynchotrema*. Costae angular with 3 (less commonly 4) in the sulcus and 5 or 6 on the flanks. Dental plates very weakly developed. Dorsal median septum low, extending to or slightly beyond valve midlength. Cardinal process a low, thin ridge.

Description. Shell up to 16.0 mm wide and 14.3 mm long. Mean length-width ratio of specimens over 12.0 mm long is 0.90 (variance 0.0029) for the ventral valve and 0.83 (variance 0.0021) for the dorsal valve. Shell moderately to strongly biconvex, subtriangular with maximum width at about two thirds shell length. Ventral valve moderately convex with maximum convexity in posterior half. In posterior view, lateral slopes slightly flattened. Sulcus arises about 7 millimetres from beak deepening fairly rapidly, forming a rounded tongue of variable length. Dorsal valve with maximum convexity in posterior half, evenly convex in posterior view. External ornament consisting of very strong, angular costae of which 3 (less commonly 4) occur in the sulcus and 5 or 6 on the flanks. Some specimens exhibit finely pustulose surface due to intersection of fine concentric fila and fine radial lirae. Other specimens only exhibit the concentric microornament, while in further specimens no microornament is visible at all. Distinct concentric lamellae are rare and usually occur anteriorly. Ventral beak suberect, partially obscuring dorsal beak. Delthyrium fairly narrow, apparently without deltidial plates.

Teeth strong, boss-like, curved, with poorly developed fossettes, supported, in larger specimens by shell wall. Dental plates remain as vertical ridges on shell wall. In smaller specimens dental plates are short, thin and ventrally divergent separating very narrow umbonal cavities from broad semiconical delthyrial cavity. Pedicle scar often indistinct, occupying entire delthyrial cavity. Ventral muscle field usually not impressed. Adductors ovate, located immediately anterior of delthyrial cavity, surrounded by diductors. Details of diductors not preserved.

Hingeplates strong, narrowly triangular concave widely divergent, with crura curving strongly ventrally from their anterior extremities. Inner socket ridge very high, thick. Outer socket ridge low. Dorsal median septum low, rounded probably extending to, or beyond, valve midlength. Septum broadens posteriorly forming distinct subrhombic to triangular notothyrial platform posterolaterally ankylosed to hingeplates. Cardinal process low, ridgelike. Dorsal muscle field not seen.

Statistics.

		Ventral Valve		
	N	M	SD	V
L/W	8	0.90	0.05	0.0029
		Dorsal Valve		
L/W	8	0.83	0.05	0.0021

Remarks. This species differs from R. increbescens (Hall) in having only rare concentric lamellae and in having considerably fewer costae. R. increbescens has from 14 to 20 costae (mean 17.37, see Howe 1979, p. C7, table 2) on the dorsal valve, whereas R. crossi has between 12 and 15 (mean 13.9) on the dorsal valve. These two species are otherwise quite similar externally.

In R. increbescens the cardinal process varies considerably, from a low ridge to a bulbous mass extending above the level of the hingeplates. In R. crossi sp. nov. the cardinal process is always a low ridge.

Rhynchotrema ?iowense Wang 1949
Plate 21, figs 23-36; Plate 22, figs 1-13.

Material. UTGD 120515-43.

Locality. Lower Limestone Member, Benjamin Limestone, on northeastern side of hill along southern branch of Sixteen Road. (Locality 5A on section F, fig 2.9) G.R. 561854 Sheet 8112, Edition 4, 1979.

Diagnosis. Medium sized, transversely ovate, moderately to strongly ventrally sulcate *Rhynchotrema*. Costae angular to slightly rounded with 3 (rarely 2 or 4) in the sulcus and between 6 and 8 on the flanks. Dental plates thin, umbonal cavities very narrow. Dorsal median septum low, narrow, extending to about midlength. Cardinal process a low ridge.

Description. Shell up to 14.4 mm wide and 11.6 mm long. Mean length-width ratio of specimens over 10.0 mm wide is 0.85 (variance 0.0008) for the ventral valve and 0.79 (variance 0.0006) for the dorsal valve. Shell strongly biconvex, transversely ovate with maximum width at about midlength. Ventral valve moderately convex with maximum convexity in posterior half. In posterior view, lateral slopes convex, median portion of valve flattened. Sulcus arises at about 6 mm from beak, deepening rapidly forming rounded to trapeziform tongue. Dorsal valve strongly convex with maximum convexity in posterior half. In posterior view lateral slopes convex, with fold indistinct to prominent. External ornament consisting of strong, angular to slightly rounded costae of which, 3 (rarely

2 or 4) occur in the sulcus and between 6 and 8 on the flanks. Fine concentric lamellae occur at anterior margin of larger specimens. Ventral beak suberect, partially obscuring dorsal beak. Delthyrium wide, with or without rudimentary deltidial plates. Teeth of moderate size boss-like or plate-like with weak groove-like fossettes, supported by thin slightly receding dental plates which separate narrow umbonal cavities from the variably broad delthyrial cavity. Indistinct pedicle scar occupies entire delthyrial cavity. Ventral muscle field subflabellate rounded trapeziform slightly impressed posteriorly, extending anteriorly about three fifths of valve length. Adductors ovate, usually indistinct, enclosed by diductors.

Hingeplates strong, narrowly triangular, weakly to moderately concave, strongly divergent with strong crura curving strongly ventrally from their anterior extremities. Outer socket ridge slightly lower than inner socket ridge. Dorsal median septum extending to about valve midlength, anteriorly septum is very low and narrow, posteriorly it broadens and below notothyrial cavity is obscured by callus. Notothyrial cavity fairly narrow, flat-bottomed with low ridge-like cardinal process. Dorsal muscle field obscure.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	8	0.85	0.03	0.0008
MFW/MFL	(0.67, 0.67)			
MFL/L	(0.56, 0.61)			
		Dorsal Valve		
L/W	8	0.79	0.02	0.0006

Remarks. These specimens are most similar to *R. iowense* Wang in their transversely ovate shape, their sulcation and in the number and distribution of their costae. Internally *R. iowense* appears to be similar in size and development of ventral muscle field, dental plates and dorsal median septum. Details of the dorsal cardinalia are however unclear, therefore no definite assignment is made.

AZAMELLA gen. nov.

Name. After Dr. Azam Ali Kwaja.

Type species. *Azamella rotunda* sp. nov.

Diagnosis. Transversely ovate, subequally biconvex with well developed ventral sulcus and dorsal fold. Costae low, rounded, crossed by regular well developed concentric lamellae. Ventral beak suberect, partially obscuring dorsal beak. Delthyrium open. Teeth supported by well developed dental plates. Hingeplates divided, strongly concave with crura directed ventrally. Dorsal median ridge long, low, narrow, posteriorly obscured by callus forming low broad pseudoseptalium. Cardinal process absent.

Remarks. Externally this genus is most similar to *Lepidocyclus* Wang and *Hypsiptycha* Wang. It differs from the former in having no marked posterior shell thickening, having no delthyrial cover, in lacking a cardinal process and in having low rounded costae. It differs from the latter in being transversely ovate, in lacking a cardinal process and in possessing low rounded costae.

Azamella rotunda sp. nov.

Plate 22, figs 14-21; Plate 23, figs 1-18.

Name. Refers to rotund nature of shell.

Material. Holotype UTGD 120566; Paratypes UTGD 120564, 120565, 120567, 120578, 120579, 120580, 120581, 120582, 120585, 120586, 120587, 120596, 120598, 120599, 120600, 120601; Other material UTGD 120568-77, 120583-4, 120588-95, 120597, 120602-3, 120654-74.

Type locality. Lower Limestone Member, Benjamin Limestone, Settlement Road Section (Locality 11 on section B in fig. 2.9) G.R. 558868 Sheet 8112, Edition 4, 1979.

Diagnosis. *Azamella* with moderately well developed sulcus with rounded tongue. Between 3 and 6 costae in sulcus and 8 to 10 costae on flanks.

Description. Shell up to 14.7 mm wide and 11.5 mm long. Mean length-width ratio, of specimens over 9.0 mm wide, is 0.86 (variance 0.0018) for the ventral valve and 0.77 (variance 0.0022) for the dorsal valve. Shell strongly biconvex, globular, transversely ovate with maximum width at about midlength. Ventral valve moderately convex with maximum convexity in posterior half, lateral slopes flattened, steeply inclined. Sulcus evident as flattened mid-portion of valve. Sulcus arises at about 6 mm from beak and deepens rapidly forming a rounded tongue of varying length. Dorsal valve strongly convex, with nearly semi-circular profile. Convexity even or with maximum in posterior half. In posterior view, maximum convexity in mid-portion, fold sometimes subcarinate in appearance, external ornament consisting of fairly strong rounded costae of which, between 3 and 6 (mode 3) occur in the sulcus with between 8 to 10 on the flanks. Intersecting the costae are well developed concentric lamellae. These lamellae are evenly spaced (0.5 to 0.8 mm) over most of exterior but at anterior margins of larger specimens they are very crowded. Ventral beak suberect, partially obscuring dorsal beak. Delthyrium broad, open.

Teeth small and boss-like, curved with poorly developed fossettes, supported by fairly thick, slightly receding dental plates, which separate narrow umbonal cavities from broad nearly conical delthyrial cavity. Pedicle scar very well developed, occupying entire delthyrial cavity. Ventral muscle field subflabellate, about three quarters as wide as long, extending anteriorly to just over half valve length. Adductors ovate, usually impressed posteriorly, anteriorly surrounded by broad diductor scars.

Hingeplates strong, narrowly triangular, strongly divergent, strongly concave, with crura extending ventrally from anterior margins of hingeplates. Sockets broad, inner socket ridge high, outer low. Dorsal median septum anteriorly low, narrow, extending anteriorly over half valve length. Septum posteriorly obscured by callus which forms a low pseudoseptalium, posteriorly ankylosed to hingeplates. Cardinal process absent. Dorsal muscle field indistinct, subcircular to subquadrate, laterally bounded by narrow ridges.

Statistics.

	Ventral Valve			
	N	M	SD	V
L/W	9	0.86	0.04	0.0018
MFW/MFL	(0.77, 0.73)			
MFL/L	(0.47, 0.57)			
	Dorsal Valve			
L/W	7	0.77	0.05	0.0022

Azamella sulcata sp. nov.

Plate 24, figs 1-28.

Name. Refers to strongly sulcate nature of shell.

Material. Holotype UTGD 120605; Paratypes UTGD 120604, 120607, 120611, 120615, 120616, 120620, 120622, 120624, 120629, 120631, 120634, 120641, 120643, 120644; Other material UTGD 120606, 120608-10, 120612-14, 120617-19, 120621, 120623, 120625-28, 120630, 120632-3, 120635-40, 120642, 120645-53.

Type locality. Lower Limestone Member of Benjamin Limestone, Settlement Road Section (Locality 16 on Section D, fig. 2.9) G.R. 558868 Sheet 8112, Edition 4, 1979.

Diagnosis. Azamella with strongly developed ventral sulcus with long trapeziform tongue. Between 3 and 5 costae in sulcus and between 8 and 12 costae on flanks.

Description. Shell up to 13.0 mm wide and 11.0 mm long. Mean length-width ratio of specimens over 9.0 mm wide is 0.84 (variance 0.0015) for ventral valve and 0.78 (variance 0.0011) for dorsal valve. Shell strongly biconvex, globular transversely ovate with maximum width at about midlength. Ventral valve moderately convex with maximum convexity in posterior half. In posterior view, lateral slopes flat or slightly convex. Sulcus evident as flattened mid-portion of valve. Sulcus arises at about 5 mm from beak and deepens rapidly forming a distinctly trapeziform tongue. Costae bounding sulcus very accentuated. Dorsal valve strongly convex with nearly semicircular profile. Convexity even or greatest in posterior half. In posterior view, maximum convexity occurs in the mid-portion, fold sometimes rectangular in section. External ornament consisting of strong, rounded costae of which between 3 and 5 (mode 3) occur in the sulcus with 7 to 14 on the flanks. Intersecting the costae are well developed concentric lamellae. The lamellae are evenly spaced (0.5 - 1.0 mm) over most of exterior but anteriorly in larger specimens they become crowded. Ventral beak suberect, partially obscuring dorsal beak. Delthyrium quite broad, open.

Teeth small and boss-like, curved, with poorly developed fossettes, supported by thin receding dental plates which separate narrow umbonal cavities from broad nearly conical delthyrial cavity. Pedicle scar poorly defined, occupying entire delthyrial cavity. Ventral muscle field subflabellate, about two thirds as wide as long, extending anteriorly about three fifths valve length, laterally bounded by low anterior extensions of dental plates. Adductors ovate, usually impressed posteriorly, anteriorly surrounded by broad diductors.

Hingeplates delicate, narrowly triangular, strongly divergent, moderately concave with crura extending ventrally from anterior margins. Sockets semiconical, inner socket ridge slightly higher than outer ridge. Dorsal median septum low, narrow, cuneiform, extending anteriorly over half valve length. Septum posteriorly obscured by broad low callus which is not ankylosed to hingeplates. Cardinal process absent. Dorsal muscle field indistinct laterally bounded by weak ridges.

Statistics.

	Ventral Valve			
	N	M	SD	V
L/W	26	0.84	0.04	0.0015
MFW/MFL	(0.64)			
MFL/L	(0.61)			
		Dorsal Valve		
L/W	18	0.78	0.03	0.0011

Remarks. *A. sulcata* differs from *A. rotunda* in having a deeper sulcus, a uniformly trapeziform tongue rather than a rounded tongue, stronger development of costae bounding the sulcus, a lower posterior dorsal callus which is not ankylosed to the hingeplates, and a relatively narrower, longer ventral muscle field bounded laterally by weak extensions of the dental plates.

Family TASMANELLIDAE fam. nov.

Diagnosis. Sulcus and fold well developed, costae strong. Rudimentary interareas in both valves. Hingeplate divided, supported by convergent crural plates which join with high median septum to form narrow V-shaped septalium. Cardinal process high, bladelike. Pedicle scar apical, muscle field short, subquadrate to ovate. Dental plates weak, receding.

TASMANELLA gen. nov.

Name. After Abel Tasman, discoverer of Tasmania.

Type species. *Tasmanella nova* sp. nov.

Diagnosis. As for family.

Remarks. This genus is most similar to *Orthorhynchula* in that it has a short ventral muscle field and interareas in both valves. It differs from this latter genus however, in having crural plates converging onto a high median septum to form a narrow V-shaped elevated septalium.

This difference in the dorsal interior of *Tasmanella* warrants differentiation at family level.

Tasmanella nova sp. nov.
Plate 24, figs 29-45.

Name. The species is newly discovered.

Material. Holotype UTGD 120675; Paratypes UTGD 120676, 120678, 120681, 120683, 120687, 120688; Other material UTGD 120677, 120679-80, 120682, 120684-6, 120689-96.

Type locality. As for ?*Plectorthis dinorthoides*.

Diagnosis. Tasmanella with well developed sulcus containing 3 (rarely 2 or 4) costae with between 8 and 10 costae on the flanks.

Description. Shell up to 18.2 mm wide and 14.8 mm long (dorsal valve). Mean length-width ratio of ventral valves 0.81 (variance 0.0047). Shell strongly biconvex, transversely ovate to subpentagonal, with maximum width at, or slightly anterior to midlength. Hingeline short, about two fifths maximum width of shell. Ventral valve strongly convex with maximum convexity in posterior half. In posterior view, lateral slopes weakly convex, sulcus evident as flat mid-portion of valve. Sulcus arising at about 5 mm from beak and deepening rapidly, forming a long rounded tongue. Dorsal valve very strongly convex with convexity being fairly even. In posterior view, lateral slopes weakly convex, fold evident as narrowly arched mid-portion of valve. External ornament consisting of strong subangular costae, of which 3 (rarely 2 or 4) occur in the sulcus and 8 to 10 on each flank. Intersecting costae are very fine closely spaced growth lines. Ventral interarea about one third as high as wide, moderately concave, apsacline. Delthyrium broad, open, apex of beak usually resorbed. Dorsal interarea low, moderately concave, apsacline or orthocline. Notothyrium broad, open.

Teeth small, rounded conical, supported by thin strongly receding dental plates which merge with valve wall lateral of muscle field. Umbonal cavities slit-like. Delthyrial cavity broadly conical. Pedicle scar small, broadly triangular occupying apical quarter or third of delthyrial cavity. Ventral muscle field impressed, ovate or subquadrate, about three quarters as wide as long, extending anteriorly slightly less than one half valve length. Adductors and diductors not differentiated.

Hingeplates strong, narrowly triangular to ovate, concave. Crura not preserved. Sockets small, pit-like. Hingeplates supported by thin crural plates which converge onto posteriorly high, thin, median septum, forming very narrow V-shaped septalium well above valve floor. Septalium occupied by relatively thick, ventrally expanding bladelike cardinal process. Dorsal median septum rapidly decreases in height anteriorly, disappearing at about valve midlength. Dorsal muscle field indistinct, subcircular to longitudinally ovate, bounded laterally by very thin, faint ridges.

Statistics.

	N	M	SD	V
	Ventral Valve			
L/W	7	0.81	0.07	0.0047
VI/HW	10	0.35	0.06	0.0034
HW/W	8	0.42	0.05	0.0022
MFW/MFL	8	0.74	0.06	0.0037
MFL/L	6	0.46	0.04	0.0020
	Dorsal Valve			
L/W	(0.81)			

Order ATRYPIDA Rzhonsnitskaya 1960

Superfamily ATRYPACEA Gill 1871

Family ZYGOSPIRIDAE Waagen 1883 (as emended by Copper, 1977)

Subfamily ZYGOSPIRINAE Waggen 1883 (as emended by Ccpper, 1977)

HALLINA Winchell & Schuchert 1892.

Type species. *Hallina saffordi* Winchell & Schuchert 1892.

Remarks. Copper (1977, p. 304-5) in discussing the genus *Anazyga* Davidson compared it closely with *Hallina* Winchell & Schuchert. He thought it possible that *Hallina* may be a junior synonym of *Anazyga*. He noted that "Winchell and Schuchert (1892) described and figured the brachidia as consisting of a single fused loop" with no evidence of spiralia. This misconception led Winchell & Schuchert (op. cit.) to assign *Hallina* to the family Terebratulidae Gray.

Copper (op. cit.) also stated that "Hall and Clarke (1893, p. 151 figs 139-141) appear to confirm the lack of a spiralium and presence of a loop, and believed that the internal structure of their genus *Protozyga* (ibid. p. 151) was nearly identical, except that *Protozyga* had the beginnings of the first spiral whorl (ibid. p. 149)". This statement is incorrect. The figures of *Hallina* referred to by Copper (Hall & Clarke 1893, p. 151, figs 139-141) show quite clearly the presence of an incipient first volution largely anterior to the jugum. Indeed, Hall and Clarke (op. cit. p. 151) further explain that Protozyga exigua (Hall 1847) and Hallina saffordi Winchell & Schuchert 1892 both "present the minimum development" of the spiralia.

Hallina inconspicua sp. nov.
Plate 25, figs 20-37; Plate 26, figs 1-4.

Name. This species forms a very small fraction of the fauna at its type locality.

Material. Holotype UTGD 120697; Paratypes UTGD 120698, 120699, 120700, 120701, 120703, 120705; Other material UTGD 120702, 120704, 120706-13.

Type locality. As for Hesperorthis benjaminensis.

Diagnosis. A moderate sized, ventribiconvex, subpentagonal Hallina with a weak ventral fold and dorsal sulcus, with about 16 angular costae on each valve.

Description. Shell up to 4.3 mm wide and 4.5 mm long. Mean length-width ratio of ventral valve, 1.09 (variance 0.0049), dorsal valve, 0.93 (variance 0.0048). Shell ventribiconvex, subpentagonal with maximum width at, or slightly posterior to midlength. Ventral valve moderately convex with convexity even or greatest at about midlength. In posterior view, ventral valve subcarinate with lateral slopes flat or slightly concave. Dorsal valve slightly convex with maximum convexity in posterior half. Sulcus narrow posteriorly, broadening and becoming less distinct anteriorly. Anterior commissure shallowly and broadly sulcate. External ornament consists of strong angular costae arising at beak, with between 13 and 18 (mode 16) costae on each valve. Ventral interarea narrow, indistinct, slightly concave. Ventral beak nearly straight. Delthyrium with small, disjunct, triangular deltidial plates, giving pedicle opening an ovate shape. Dorsal interarea obsolete.

Teeth small, boss-like, curved, supported by thin, well developed dental plates which separate relatively large umbonal cavities from the subconical delthyrial cavity. Muscle field unknown.

Hingeplates disjunct, medially slightly divergent, ankylosed to broad median ridge, forming semiconical notothyrial cavity. Cardinal process low, ridgelike. Dorsal muscle field unknown. Crura arise from inner margins at hingeplates, curving laterally, diverging from each other at an angle of about 70°, then curving inwardly. Only about one half to three quarters of first spiral whorl complete. Jugum broadly U-shaped, located at, or posterior to axis of spiralia.

Statistics.

		Ventral Valve		
	N	M	SD	V
L/W	10	1.09	0.07	0.0049
		Dorsal Valve		
L/W	10	0.93	0.07	0.0048

Remarks. *Hallina inconspicua* sp. nov. is characterised by its relatively few, strong, angular costae. In this respect it is most similar to *H. canadensis* Steele & Sinclair 1971. It differs from this species, however, in having a greater length-width ratio, a pentagonal rather than subcircular outline and in lacking the accentuated median costa in the dorsal sulcus.

PROTOZYGA Hall & Clarke 1893.

Type species. Atrypa exigua Hall 1847.

Protozyga aseptata sp. nov.
Plate 26, figs 5-14.

Material. Holotype UTGD 120715; Paratypes UTGD 120716, 120717, 120718, 120719, 120721, 120722, 120723; Other material UTGD 120720, 120724-31.

Type locality. As for Rhynchotrema ?iowense Wang.

Diagnosis. A moderate sized, ventribiconvex, subpentagonal Protozyga with a strong, smooth ventral fold and dorsal sulcus, well developed subparallel dental plates and very weak dorsal median ridge.

Description. Shell up to 3.4 mm wide and 3.6 mm long. Mean length-width ratio of ventral valve 1.13 (variance 0.0024), dorsal valve 1.01 (variance 0.0029). Shell ventribiconvex, subpentagonal with maximum width at about midlength. Ventral valve moderately to strongly convex with maximum convexity at about midlength. In posterior view median portion of valve very strongly convex, lateral slopes slightly concave. Dorsal valve slightly to moderately convex with maximum convexity in posterior half. Sulcus arising posterior of midlength, broadening rapidly and deepening slowly toward the anterior margin. Anterior commissure broadly sulcate, sulcus with steep sides and slightly flattened bottom. Ventral interarea vestigial. Pedicle foramen ovate, bounded by small triangular deltidial plates. Dorsal interarea obsolete.

Teeth small, boss-like, curved, supported by well developed subparallel dental plates. Muscle field obscure.

Hingeplates disjunct. Dorsal median ridge absent or very weakly developed at about valve midlength. Cardinal process absent. Dorsal muscle field not observed. Crura arise from inner margins of hingeplates, passing anteriorly a short distance, then abruptly turning laterally, diverging from one another at about 70 degrees. Only about one half to two thirds of first spiral whorl complete. Jugum not seen.

Statistics.

	N	M	SD	V
		Ventral Valve		
L/W	7	1.13	0.05	0.0024
		Dorsal Valve		
L/W	7	1.01	0.05	0.0029

Remarks. P. exigua (Hall) and P. perplexa Williams are the only other two species of the genus which often have an unmodified ventral fold and dorsal sulcus. However, some adult specimens of P. exigua have an indistinct paucicostate ornament at the anterior margin. Conversely P. perplexa is not known with a modified sulcus and fold, although Mitchell (1977) noted weak anterior paucicostae in P. cf. perplexa from County Tyrone. Mitchell's specimens were considerably larger than those in the type lot of P. perplexa so it is possible that paucicostae are a feature of the late adult stages of P. perplexa.

Internally *P. aseptata* sp. nov. can be distinguished from both *P. exigua* and *P. perplexa* by its lack of a well developed dorsal median ridge.

?Family ZYGOSPIRIDAE Waagen 1883.

CRYPTOSPIRA gen. nov.

Name. No spiralia are preserved in type lot.

Type species. *Cryptospira intraplicata* sp. nov.

Diagnosis. Transversely ovate to subpentagonal, ventribiconvex to nearly planoconvex, coarsely costate, costae subangular. Anterior commissure intraplicate with median sulcus on ventral fold bounded by accentuated costae and containing two or three weaker costae. Beak nearly straight, ventral interarea absent or rudimentary, details of delthyrium not seen.

Teeth large, widely spaced, dental plates absent in adult specimens. Pedicle scar occupying entire deep narrow delthyrial cavity. Ventral muscle field subflabellate, quadrilobate, deeply impressed posteriorly.

Hingeplates small, disjunct. Notothyrial cavity narrow, with or without low ridgelike cardinal process.

Dorsal muscle field elongate, ovate, deeply impressed posteriorly bisected by anteriorly tapering dorsal median ridge. Spiralia unknown.

Remarks. This genus is most similar to *Megumatrypa* Harper 1973, from which it differs in having a distinctly intraplicate anterior commissure and a smaller, more posteriorly located subflabellate ventral muscle field. *Cryptospira* differs from *Zygospira* Hall 1862 in having a posteriorly much thickened shell wall, lacking dental plates and in having an intraplicate anterior commissure. *Cryptospira* differs from *Zygospiraella* Nikiforova 1961 in having a divided hingeplate and an intraplicate anterior commissure. *Zygatrypa* Copper 1977 differs in having a strongly incurved ventral beak and in lacking costae near the posterior margin of the shell.

Cryptospira intraplicata sp. nov.
Plate 24, figs 46-48; Plate 25, figs 1-19.

Name. Refers to intraplicate nature of anterior commissure.

Material. Holotype UTGD 120780; Paratypes UTGD 99481, 120774, 120775, 120778, 120787, 120789, 120793, 120795, 120796, 120798, 120802; Other material UTGD 99474, 120776-7, 120779-86, 120788, 120790-2, 120794, 120797, 120799-801, 120803-5.

Type locality. As for Isorthis (Ovalella) arndellensis.

Diagnosis. As for genus.

Description. Shell up to 12.7 mm wide and 10.6 mm long. Mean length-width ratio of specimens over 10.0 mm wide, is 0.85 (variance 0.0079) for ventral valves and 0.73 (variance 0.0019) for dorsal valves. Shell ventribiconvex to nearly planoconvex, thickness about one third length, transversely ovate to subpentagonal with maximum width at about midlength. Ventral valve moderately convex with maximum convexity in posterior half. In posterior view, lateral slopes flat, separated from narrow flattened median portion by accentuated costae. Ventral fold broad with broad flat-bottomed median plication of similar amplitude to fold. Dorsal valve weakly convex with maximum convexity in posterior half. In posterior view lateral slopes slightly convex with midportion flat or slightly concave. External ornament consisting of strong subangular costae, of which three or two occur in the median sulcus of the ventral fold. This sulcus is bounded by accentuated costae. Including accentuated costae there are 9 or 10 costae on either flank. Growth lines rarely evident. Ventral beak nearly straight, prominent, with or without rudimentary interarea. Delthyrium not observed.

Teeth large, triangular in section, supported by small receding dental plates in smaller specimens. Dental plates obsolete in larger specimens. Pedicle scar well developed, occupying entire delthyrial cavity. Ventral muscle field subflabellate, quadrilobate, averaging over four fifths as wide as long, extending anteriorly just over half valve length. Each lobe of the diductors triangular. Adductors longitudinally ovate, anteriorly surrounded by diductors.

Hingeplates small, disjunct, notothyrial cavity narrow, of variable depth, with or without low ridgelike cardinal process. Sockets large ovate. Dorsal median septum broad, tapering anteriorly extending nearly to anterior margin of dorsal muscle field. Dorsal muscle field longitudinally ovate, just over half as wide as long, extending anteriorly about three fifths valve length. Posterior adductors narrow, curved (convex laterally), deeply impressed, located postero-lateral of larger triangular anterior adductors.

Statistics.

		Ventral Valve		
	N	M	SD	V
L/W	6	0.85	0.09	0.0079
MFW/MFL	4	0.84	0.01	0.0002
MFL/L	4	0.55	0.10	0.0098
		Dorsal Valve		
L/W	4	0.73	0.04	0.0019
MFW/MFL	7	0.53	0.05	0.0027
MFL/L	6	0.60	0.03	0.0011

CHAPTER TEN

CONCLUDING REMARKS

Articulate brachiopods are a major component of the Ordovician and earliest Silurian marine faunas of Tasmania. They, along with the trilobites are probably the most widespread (in both the vertical and horizontal senses) elements of these faunas. Because of this ubiquitous nature they are an excellent biostratigraphic tool for correlation of the Ordovician and Silurian sequences within Tasmania.

The 60 species described herein are distributed among 20 zones and one informal assemblage. The zones in ascending order are: *Apheoorthis humboldtensis* zone which is characterised by *A. humboldtensis* Laurie 1980; *Nanorthis carinata* zone which contains *N. carinata* Laurie 1980 and basally *Apheoorthis humboldtensis* Laurie 1980; *Tritoechia lewisi* zone which contains *T. lewisi* Brown 1948 and *Syntrophopsis karmbergi* Brown 1948; *Tritoechia florentinensis* zone which is characterised by *T. florentinensis* Laurie 1980; ? *Tritoechia careyi* zone which contains ? *T. careyi* Brown 1948; *Leptella corbetti* zone which contains *L. corbetti* sp. nov., *Tritoechia karmbergensis* Laurie 1980 and *Archaeorthis subcarinata* Laurie 1980;

Hesperonomiella jurikae zone which contains *H. jurikae* sp. nov. only; *Railtonella scanloni* zone which contains *R. scanloni* gen. et sp. nov. and *Hesperonomiella jurikae* sp. nov.; *Aporthophyla staiti* zone which contains *A. staiti* sp. nov.; *Leptellina sulcata* zone which contains *L. sulcata* sp. nov.; *Lepidomena fortimuscula* zone which contains *L. fortimuscula* gen. et sp. nov., *Rhynchotrema bailliei* sp. nov., *Apatomorpha melrosensis* sp. nov., ? *Strophomena* sp., *Bellimurina* cf. *compressa* Cooper 1956, *Hesperorthis longirostroides* sp. nov., *Dactylogonia rara* sp. nov., *Chaganella* sp., *Maydenella asymmetrica* gen. et sp. nov., *Teratelasmella plicata* gen. et sp. nov. and an oepikinid gen. et sp. indet.; *Lepidomena pulchra* zone which contains *L. pulchra* gen. et sp. nov., *Oepikina banksi* sp. nov., *Hesperorthis longirostroides* sp. nov., *Rhynchotrema bailliei* sp. nov. and *Chaganella* sp.; *Tasmanorthis calveri* zone which contains *T. calveri* gen. et sp. nov., *Azamella rotunda* gen. et sp. nov. and *Rhynchotrema ponderosa* sp. nov.; *Tasmanorthis costata* zone which contains *T. costata* gen. et sp. nov., *Azamella sulcata* gen. et sp. nov., *Macrocoelia stenomuscula* sp. nov., *Skenidioides alatus*, sp. nov., *Ptychopleurella magna* sp. nov., *Rhynchotrema crossi* sp. nov. and *Murinella magna* sp. nov.; *Strophomena* cf. *oklahomensis* zone which contains *S.* cf. *oklahomensis* Cooper 1956, *Tasmanorthis costata* gen. et sp. nov., *Ptychopleurella* cf. *magna* sp. nov. and

Azamella sulcata gen. et sp. nov.; Dinorthis westfieldensis zone which contains D. westfieldensis sp. nov., Strophomena burretti sp. nov., Rhynchotrema ? iowense Wang 1949, Protozyga aseptata sp. nov., Hallina inconspicua sp. nov., Macrocoelia brownae sp. nov., Tasmanella nova gen. et sp. nov., Ptychopleurella cf. magna sp. nov., Hesperorthis benjaminensis sp. nov., Sowerbyites vesciseptus Percival 1979, Holtedahlina sp., Leptellina sp., Vellamo sp., Sowerbyella (Sowerbyella) cf anticipata Percival 1979 and Sowerbyella (Sowerbyella) ?lepta Percival 1979; ?Plectorthis dinorthoides zone which contains ?P dinorthoides sp. nov. and Tasmanella nova gen. et sp. nov.; Dinorthis holdenoides zone which contains D. holdenoides sp. nov.; Isorthis (Ovalella) arndellensis zone which contains I. (O.) arndellensis sp. nov., Hirnantia enorme sp. nov. and Cryptospira intraplicata gen. et sp. nov.; ?Onniella perplexa zone which contains ?O. perplexa sp. nov., Isorthis (Ovalella) arndellensis sp. nov., ?Eospirifer sp., Hirnantia sp. At the top of the Gordon Subgroup in the Florentine Valley is a single horizon containing Kinnella ?kielanae (Temple) and an indeterminate leptaenid.

The Tasmanian faunas, notably the deeper water faunas from the south coast, have species in common with New South Wales but few real correlations of Tasmanian brachiopod faunas with those of mainland Australia can be made because of the lack of sufficient knowledge of the latter.

Intercontinental correlations using brachiopods is possible at a generic level but most, if not all, of the species described herein are endemic therefore no specific correlations can be made. Intercontinental correlations proposed herein are largely achieved by evidence from graptolites and conodonts. Correlations are summarised in fig 6.2.

Although no quantitative biogeographic analysis has been undertaken, qualitatively the Tasmanian brachiopod faunas have strong affinities with those of the North American Realm, particularly those of Southern China and Kazakhstan.

A brachiopod fauna associated with a small stromatoporoid mound in the Cashions Creek Limestone proved to be much more diverse than, and to have few genera in common with, the faunas associated with the surrounding sediments. Associated with the mound are both robust shells with pronounced commissural asymmetry and delicate shells with strong ventral sulcation. The former are interpreted to have occupied exposed portions of the mound whilst the rarer latter form is thought to have inhabited protected recesses within the mound.

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APPENDIX 4

FOSSIL CATALOGUE

All specimens are held in the Geology Department, University of Tasmania. All locality data is given in Chapter 9 or in Appendices 2 or 3

Catalogue No.	Species	Locality
97337-47	<u>Apheoorthis</u> <u>humboldtensis</u> Laurie	Type
97348-63	<u>Nanorthis</u> <u>carinata</u> Laurie	Type
97364-86	<u>Tritoechia</u> <u>lewisi</u> Brown	See Appendix 3
97387-413	<u>Tritoechia</u> <u>florentinensis</u> Laurie	Type
97414-26	?<u>Tritoechia</u> <u>careyi</u> Brown	Type
97427-42	<u>Tritoechia</u> <u>karmbergensis</u> Laurie	Type
97443-56	<u>Archaeorthis</u> <u>subcarinata</u> Laurie	Type
97457-77	<u>Leptella</u> <u>corbetti</u> sp. nov.	Type
99037-43	<u>Skenidioides</u> <u>alatus</u> sp. nov.	Type
99044-90	<u>Dinorthis</u> <u>westfieldensis</u> sp. nov.	Type
99091-117	<u>Dinorthis</u> <u>holdenoides</u> sp. nov.	Type
99118-49	<u>Hesperorthis</u> <u>longirostroides</u> sp. nov	as for 99906-34
99150-8	<u>Hesperorthis</u> <u>benjaminensis</u> sp. nov.	Type
99159-220	?<u>Plectorthis</u> <u>dinorthoides</u> sp. nov.	Type
99221-70	<u>Tasmanorthis</u> <u>costata</u> gen. et. sp. nov.	Type

Catalogue No.	Species	Locality
99271-334	Tasmanorthis calveri gen. et. sp. nov.	as for 120501-14
99335-40	as for 99221-70	Type
99341-90	Tasmanorthis calveri gen. et. sp. nov.	Type
99391-440	Ptychopleurella magna sp. nov.	Type
99441-65	Ptychopleurella cf. magna sp. nov.	as for 99150-8
99466-500	Isorthis (Ovalella) arndellensis sp. nov.	Type
99501-8	Hirnantia enorme sp. nov.	Type
99509-25	Hirnantia enorme sp. nov.	Locality 2 in fig.2.11
99526-30	Isorthis (Ovalella) arndellensis sp. nov.	as for 99509-25
99531-4	Hirnantia enorme sp. nov.	as for 99509-25
99535-74	?Onniella perplexa sp. nov.	Type
99575-86	Kinnella ?kielanae (Temple)	see Chapter 9
99587-90	Hirnantia sp.	as for 99575-86
99591-639	Hesperonomiella jurikae	Locality B in fig. 3.2
99640-69	Teratelasmella plicata gen. et. sp. nov.	Type
99670-85	Dactylogonia rara sp. nov.	Type
99686-701	Bellimurina aff compressa Cooper	as for 99640-69
99702-8	Chaganella sp.	as for 99640-69

Catalogue No.	Species	Locality
99709-20	Oepikinid gen. et. sp. indet.	as for 99640-69
99721-64	Maydenella asymmetrica gen. et. sp. nov.	Type
99765-9	?Maakina sp.	as for 99640-69
99770-7	?Strophomena sp.	as for 99640-69
99778-86	Oepikina banksi sp. nov.	Type
99787-802	Murinella magna sp. nov.	Type
99803-15	Sowerbyites vesciseptus Percival	Locality 4a on section E fig. 2.9
99816-45	Railtonella scanloni gen. et. sp. nov.	Type
99846-77	Apatomorpha melrosensis sp. nov.	Locality B on fig. 2.7
99878-905	Leptellina sulcata sp. nov.	Type
99906-34	Lepidomena pulchra gen. et. sp. nov.	Type
99935-68	Lepidomena fortimuscula gen. et. sp. nov.	Type
99969-93	Strophomena cf. oklahomensis Cooper	Locality 2 on section E fig. 2.9
99994-9	Strophomena burretti sp. nov.	Type
120101-75	as for 99994-9	Type
120176-92	Holtedahlina sp.	as for 99441-65
120193-232	Macrocoelia stenomuscula sp. nov.	Type
120233-41	Sowerbyella cf. anticipata Percival	see Appendix 2

Catalogue No.	Species	Locality
120242-3	Vellamo sp.	as for 120233-41
120244-52	Murinella magna sp. nov.	Type
120253-5	Leptellina sp.	as for 120233-41
120256-92	Hesperonomiella jurikae sp. nov.	Type
120293-319	Railtonella scanloni gen. et. sp. nov.	Type
120320-95	Apatomorpha melrosensis sp. nov.	Type
120396-449	Aporthophyla staiti sp. nov.	Type
120450-4	Macrocoelia brownae sp. nov.	Type
120455-500	Rhynchotrema bailliei sp. nov.	Type
120501-14	Rhynchotrema ponderosa sp. nov.	Type
120515-43	Rhynchotrema ?iowense Wang	Locality 5A on section F fig. 2.9
120544-63	Rhynchotrema crossi sp. nov.	Type
120564-603	Azamella rotunda gen. et. sp. nov.	Type
120604-53	Azamella sulcata gen. et. sp. nov.	Type
120654-74	Azamella rotunda gen. et. sp. nov.	Type
120675-96	Tasmanella nova gen. et. sp. nov.	Type
120697-713	Hallina inconspicua sp. nov.	Type
120714	Hallina inconspicua sp. nov.	as for 99994-9
120715-31	Protozyga aseptata sp. nov.	Type
120732-73	Hesperorthis longirostroides sp. nov.	Type
120774-805	Cryptospira intraplicata gen. et. sp. nov.	Type
120806-51	Sowerbyella ?lepta Percival	see Appendix 3

PLATE 1

A. *Hesperonomiella jurikae* sp. nov.

All x2. All natural moulds except where noted.

1. UTGD 120258, paratype dorsal interior.
2. UTGD 120270, dorsal interior.
3. UTGD 120286b, paratype dorsal interior.
4. UTGD 120256, paratype dorsal interior.
5. UTGD 120263, dorsal interior.
6. UTGD 120267, dorsal interior.
7. UTGD 120259, dorsal interior.
8. UTGD 120265, dorsal cardinalia.
9. UTGD 120292, paratype dorsal interior.
10. UTGD 120271, juvenile dorsal interior.
11. UTGD 120257, juvenile dorsal interior.
12. UTGD 120286a, paratype dorsal exterior, latex mould.
13. UTGD 120264, ventral interior.
14. UTGD 120288, holotype ventral interior.
    Note well preserved traces of vascular canal system.
15. UTGD 120260, paratype ventral interior.
16. UTGD 120282, ventral interior.
17. UTGD 120274, ventral interior.
18. UTGD 120269, ventral interior.
19. UTGD 120289a, paratype ventral interior.

B. _Hesperorthis benjaminensis_ sp. nov.

All x2. All silicified specimens.

20,21. UTGD 99151, paratype ventral valve.
Ventral and posterior views respectively.

22, 23, 26, 27. UTGD 99150, holotype ventral valve.
Ventral, internal, lateral and posterior views respectively.

24. UTGD 99158, paratype dorsal interior.

25, 28, 29, 30. UTGD 99153, paratype ventral valve.
Internal, ventral, lateral and posterior views respectively.

PLATE 2

A. *Hesperorthis benjaminensis* sp. nov.

All x2. All silicified specimens.

1. UTGD 99157, paratype dorsal interior.
2. UTGD 99152, paratype ventral interior.
3. UTGD 99158, paratype dorsal exterior.

B. *Hesperorthis longirostroides* sp. nov.

All x2. All silicified specimens.

4, 5, 7. UTGD 120749, juvenile ventral valve. Ventral, posterior and lateral views respectively.

6, 8, 9, 10. UTGD 120734, juvenile articulated specimen. Lateral, dorsal, posterior and ventral views respectively.

11, 12, 13. UTGD 120761, juvenile dorsal valve. External, internal and lateral views respectively.

14, 18, 19. UTGD 120760, dorsal valve. Lateral, external and internal views respectively.

15, 16. UTGD 120754, paratype dorsal valve. External and lateral views respectively.

17, 22. UTGD 120733a, holotype, dorsal valve. Lateral and external views respectively.

20, 21. UTGD 120755, paratype dorsal valve. Lateral and external views respectively.

23, 24, 25. UTGD 120769, dorsal valve. Internal, external and lateral views respectively.

26, 30, 31. UTGD 120773, dorsal valve. Lateral, internal and external views respectively.

27, 28, 29. UTGD 120766, dorsal valve. External, internal and lateral views respectively.

32, 33, 34. UTGD 120767, dorsal valve. Lateral, internal and external views respectively.

35, 36, 41. UTGD 120770, dorsal valve. Internal, external and lateral views respectively.

37, 38, 39. UTGD 120771, dorsal valve. Lateral, internal and external views respectively.

40, 43, 44. UTGD 120763, paratype dorsal valve. Lateral, internal and external views respectively.

42, 45, 46. UTGD 120764, paratype dorsal valve. Lateral, internal and external views respectively.

PLATE 3

Hesperorthis longirostroides sp. nov.

All x2. All silicified specimens.

1, 2, 3. UTGD 120765, paratype dorsal valve. Internal, external and lateral views respectively.

4, 5, 10. UTGD 120768, dorsal valve. Lateral, internal and external views respectively.

6, 7, 8. UTGD 120772, dorsal valve. Internal, external and lateral views respectively.

9, 11, 12. UTGD 120762, paratype dorsal valve. Lateral, internal and external views respectively.

13, 14, 15, 16. UTGD 120745, ventral valve. Lateral, posterior, external and internal views respectively.

17, 18, 22, 23. UTGD 120742, paratype ventral valve. External, internal, posterior and lateral views respectively.

19, 20, 21, 24. UTGD 120747, juvenile ventral valve. External, lateral, posterior and internal views respectively.

25, 29, 30, 35. UTGD 120743, paratype ventral valve. Posterior, lateral, internal and external views respectively.

26, 27, 28, 31. UTGD 120744, paratype ventral valve. Internal, posterior, lateral and external views respectively.

32, 33, 34. UTGD 120733b, holotype, ventral valve (dorsal valve illustrated on Pl. 2, figs 17, 22). External, lateral and posterior views respectively.

PLATE 4

A. <u>Hesperorthis</u> <u>longirostroides</u> sp. nov.

All x2. All silicified specimens.

1, 2, 3, 4. UTGD 120740, paratype ventral valve. Internal, external, posterior and lateral views respectively.

5, 6, 7, 8. UTGD 120741, paratype ventral valve. Posterior, lateral, internal and external views respectively.

B. <u>Ptychopleurella</u> <u>magna</u> sp. nov.

All x2. All silicified specimens.

9, 10. UTGD 97188, paratype ventral valve. Internal and external views respectively.

11, 12. UTGD 97186, paratype ventral valve. Internal and external views respectively.

13, 18. UTGD 99396, paratype dorsal valve. Internal and external views respectively.

14, 15. UTGD 99391, paratype ventral valve. External and internal views respectively.

16, 17. UTGD 97187, holotype ventral valve. External and internal views respectively.

19, 20. UTGD 99416, paratype dorsal valve. Internal and external views respectively.

21, 22. UTGD 99413, paratype dorsal valve. Internal and external views respectively.

23, 24. UTGD 99393, paratype ventral valve.

Internal and external views respectively.

C. <u>Ptychopleurella</u> cf. <u>magna</u> sp. nov.

All x3. All silicified specimens.

25, 26. UTGD 99441, ventral valve.

Internal and external views respectively.

27, 32. UTGD 99447, dorsal valve.

Internal and external views respectively.

28, 29. UTGD 99444, dorsal valve.

Internal and external views respectively.

30. UTGD 99443, ventral valve exterior.

31. UTGD 99450, dorsal valve interior.

33. UTGD 99449, dorsal valve interior.

Note cup-like sockets.

34. UTGD 99448, dorsal valve exterior.

35. UTGD 99442, ventral valve interior.

36. UTGD 99445, dorsal valve interior.

37. UTGD 99446, ventral valve exterior.

PLATE 5

A. *Dinorthis westfieldensis* sp. nov.

All x2. All silicified specimens.

1, 2, 5. UTGD 99061, holotype ventral valve.

External, internal and lateral views respectively.

3, 4. UTGD 99065, paratype ventral valve.

External and internal views respectively.

6. UTGD 99062, juvenile ventral interior.

7, 8, 10. UTGD 99088, paratype dorsal valve.

External, internal and lateral views respectively.

9, 13. UTGD 99045, paratype ventral valve.

External and internal views respectively.

11, 12. UTGD 99086, paratype dorsal valve.

External and internal views respectively.

14. UTGD 99070, paratype dorsal interior.

15. UTGD 99069, paratype dorsal interior.

B. *Dinorthis holdenoides* sp. nov.

All x1.8. All silicified specimens.

16, 17, 21, 25. UTGD 99116, paratype dorsal valve.

External, posterior, internal and lateral views respectively.

18, 22, 27. UTGD 99108, paratype dorsal valve.

Internal, external and posterior views respectively.

19. UTGD 99092, paratype ventral interior.

20. UTGD 99093, paratype ventral interior.

23, 28, 29. UTGD 99111, paratype dorsal valve.

External, lateral and internal views respectively.

24. UTGD 99097, paratype ventral interior.

26, 30. UTGD 99096, paratype juvenile ventral valve.

Internal and external views respectively.

PLATE 6

A. *Dinorthis holdenoides* sp. nov.

All x1.8. All silicified specimens.

1, 2, 3, 4. UTGD 99106, paratype dorsal valve. External, internal, posterior and lateral views respectively.

5, 6. UTGD 99107, paratype dorsal valve. Internal and external views respectively.

7, 8, 9, 10, 11. UTGD 99091, holotype ventral valve. Lateral, external, anterior, posterior and internal views respectively.

B. ?*Plectorthis dinorthoides* sp. nov.

All x2 except where noted. All silicified specimens.

12. UTGD 99219, articulated juvenile, posterior view.

13, 15, 16. UTGD 99199, paratype ventral valve. External, lateral and posterior views respectively.

14. UTGD 99200, paratype ventral interior.

17. UTGD 99201, paratype ventral interior.

18, 19, 20, 21, 23, 24. UTGD 99190, holotype ventral valve. Lateral, external, internal, enlarged internal, anterior and posterior views respectively. Fig 21, x4.

22, 28. UTGD 99193, paratype ventral valve. Internal and external views respectively.

25. UTGD 99164, paratype dorsal interior.

26, 32. UTGD 99163, paratype dorsal valve.

External and lateral views respectively.

27, 29, 33. UTGD 99195, paratype ventral valve.

Internal, lateral and external views respectively.

30, 34. UTGD 99191, paratype ventral valve.

External and posterior views respectively.

31, 36, 37. UTGD 99159, paratype dorsal valve.

External, internal and enlarged internal views respectively. Fig 37, x4.

35. UTGD 99197, paratype ventral interior.

PLATE 7

A. ?*Plectorthis* *dinorthoides* sp. nov.

All x2 except where noted. All silicified specimens.

1. UTGD 99165, paratype dorsal interior.

2, 4. UTGD 99167, paratype juvenile dorsal valve.
Enlarged internal and internal views respectively.
Fig. 2, x5.

3, 5, 6. UTGD 99168, paratype dorsal valve.
Anterior, external and internal views respectively.

7. UTGD 99172, paratype dorsal interior.

8. UTGD 99170, paratype dorsal interior.

9. UTGD 99171, paratype dorsal interior.

B. *Tasmanorthis* *costata* gen. et. sp. nov.

All x2 except where noted. All silicified specimens.

10, 11, 12, 14. UTGD 99235, holotype ventral valve.
External, internal, posterior and lateral views respectively.

13, 15, 20, 21. UTGD 99223, paratype ventral valve.
Lateral, posterior, external and internal views respectively.

16, 17. UTGD 99226, paratype ventral valve.
Internal and external views respectively.

18, 19. UTGD 99236, paratype ventral valve.
External and internal views respectively.

22, 23. UTGD 99239, paratype ventral valve.
External and internal views respectively.

24, 25. UTGD 99240, paratype ventral valve.

External and posterior views respectively.

26. UTGD 99249, paratype dorsal interior.

27, 28. UTGD 99245, paratype dorsal valve.

External and internal views respectively.

29. UTGD 99335, detail of external ornament of dorsal valve. x8.

30, 31, 33. UTGD 99268, paratype dorsal valve.

Anterior, external and lateral views respectively.

32, 34, 37, 38. UTGD 99241, paratype dorsal valve.

Lateral, external, posterior and anterior views respectively.

35, 39, 40. UTGD 99242, paratype dorsal valve.

Lateral, external and anterior views respectively.

36. UTGD 99270, paratype dorsal cardinalia.

Anterior view. x4.

C. *Tasmanorthis calveri* gen. et. sp. nov.

All x2 except where noted. All silicified specimens.

41, 42, 43. UTGD 99390, holotype ventral valve.

External, internal and lateral views respectively.

44, 49, 50, 54. UTGD 99342, paratype ventral valve.

Anterior, internal, lateral and external views respectively.

45, 46, 47, 48. UTGD 99341, paratype ventral valve.

Internal, external, lateral and anterior views respectively.

51, 55, 56, 60. UTGD 99343, paratype gerontic ventral valve. External, internal, anterior and lateral views respectively.

52. UTGD 99271, ventral interior, specimen from Westfield section, Florentine Valley.

53. UTGD 99346, detail of external ornament of paratype dorsal valve. x5.

57, 58, 59. UTGD 99344, paratype ventral valve. External, anterior and lateral views respectively.

61. UTGD 99273, ventral interior, specimen from Westfield section, Florentine Valley.

62. UZGD 99272, ventral interior, specimen from Westfield section, Florentine Valley. x4.

PLATE 8

A. <u>Tasmanorthis</u> <u>calveri</u> gen. et. sp. nov.

All x2 except where noted. All silicified specimens.

1, 2, 6, 7, 8. UTGD 99349, paratype dorsal valve.
Internal, external, internal oblique, anterior and lateral views respectively.

3, 4, 9, 11. UTGD 99346, paratype dorsal valve.
Internal, external, lateral and anterior views respectively.

5, 10, 12, 13. UTGD 99351, paratype dorsal valve.
External, lateral, anterior and interior views respectively.

14, 15, 16, 17. UTGD 99357, paratype dorsal valve.
Internal, external, anterior and lateral views respectively.

18, 19. UTGD 99358, paratype dorsal valve.
Internal and enlarged oblique internal views respectively. Fig 19, x5.

20. UTGD 99359, paratype dorsal cardinalia. x5.

21. UTGD 99361, paratype dorsal interior.

22, 23. UTGD 99362, paratype dorsal valve.
Enlarged oblique internal and internal views respectively. Fig 22, x5.

24. UTGD 99375, paratype dorsal interior.

B. *Skenidioides alatus* sp. nov.

All x5. All silicified specimens.

25, 26, 27, 32. UTGD 99039, paratype ventral valve. Posterior, lateral, internal and external views respectively.

28, 29, 33, 34. UTGD 99038, holotype dorsal valve. Anterior, posterior, external and internal views respectively.

30, 31, 35. UTGD 99037, paratype dorsal valve. Anterior, external and internal views respectively.

C. *Hirnantia enorme*

All x1.5. All natural moulds.

36. UTGD 99506, paratype dorsal cardinalia.

37, 41, UTGD 99503a, paratype dorsal interior. Fig 41, enlarged dorsal cardinalia, x2.5.

38. UTGD 99508aI, paratype dorsal interior.

39. UTGD 99507b, paratype juvenile dorsal interior.

40. UTGD 99508bIII, paratype dorsal interior.

42. UTGD 99504, paratype ventral interior.

43. UTGD 99508bII, paratype ventral exterior.

44. UTGD 99413II, paratype dorsal interior.

45. UTGD 99413I, paratype dorsal interior.

46. UTGD 99501, holotype ventral interior.

47. UTGD 99502, paratype ventral interior.

PLATE 9

A. *Hirnantia enorme* sp. nov.

1. UTGD 99508bI, paratype dorsal exterior (counterpart illustrated Pl.8 fig 38). x1.5.

B. *Hirnantia* sp.

All x3. All natural moulds.

2,3. UTGD 99587b,a, dorsal interior and exterior respectively.

4. UTGD 99589, dorsal interior.

C. *Kinnella ?kielanae*

All x2 except where noted. All natural moulds except where noted.

5, 8. UTGD 99575, dorsal interior. Fig 5, latex mould, x3.

6. UTGD 99584, dorsal interior.

7. UTGD 99576, ventral interior.

9, 10. UTGD 99585, latex mould of ventral exterior. External and lateral views respectively.

D. *Isorthis (Ovalella) arndellensis*.

All x1.3 except where noted. All natural moulds.

11. UTGD 99479II, paratype dorsal interior.

12. UTGD 99481I, dorsal interior.

13. UTGD 99478, paratype dorsal interior.

14. UTGD 99474, paratype dorsal interior.

15. UTGD 99486, dorsal cardinalia. x2.5.

16. UTGD 99481II, dorsal interior.

17. UTGD 99473II, dorsal cardinalia. x2.5.

18. UTGD 99479III, paratype dorsal interior.

19. UTGD 99476, paratype dorsal interior.

20. UTGD 99491, dorsal interior.

21. UTGD 99475, dorsal interior.

22. UTGD 99477, dorsal interior.

23. UTGD 99488, dorsal exterior.

24. UTGD 99493, ventral exterior.

25. UTGD 99479I, paratype ventral interior.

26. UTGD 99470, paratype ventral interior.

27. UTGD 99468a, paratype ventral interior.

28. UTGD 99469, paratype ventral interior.

29. UTGD 99467, paratype ventral interior.

30. UTGD 99472, ventral interior.

31. UTGD 99471, ventral interior.

32. UTGD 99466, holotype ventral interior.

E. ?Onniella perplexa sp. nov.

All x1.5. All natural moulds except where noted.

33. UTGD 99552, dorsal interior.

34. UTGD 99565, juvenile dorsal interior.

35. UTGD 99561, dorsal interior.

36, 37. UTGD 99542I, paratype dorsal interior.
Fig 36, latex mould.

38. UTGD 99571, paratype dorsal interior.

39. UTGD 99568I, dorsal interior.

40. UTGD 99572, paratype dorsal interior.

41. UTGD 99547I, paratype dorsal interior.

42, 43. UTGD 99573, paratype dorsal interior.
Fig 42, latex mould.

PLATE 10

A. ?*Onniella perplexa* sp. nov.

All x1.5. All natural moulds except where noted.

1, 13. UTGD 99556a, b, paratype dorsal valve.

Interior and exterior counterparts respectively.

2. UTGD 99551, dorsal interior.

3. UTGD 99559b, paratype dorsal interior.

4. UTGD 99562(II), paratype ventral interior.

5. UTGD 99562(I), paratype ventral interior.

6, 8. UTGD 99539b, a,(I), holotype ventral valve.

Interior counterpart and latex mould of exterior respectively.

7. UTGD 99541, paratype ventral interior.

9. UTGD 99548a, paratype ventral interior.

10. UTGD 99574, ventral exterior.

11. UTGD 99539a(II), paratype latex mould of dorsal exterior.

12. UTGD 99535, ventral interior.

B. ?*Tritoechia careyi* Brown 1948.

x2. Both latex moulds.

15,15. UTGD 97418a,b, dorsal valve.

Interior and exterior respectively.

C. *Vellamo* sp.

All x2. All natural moulds.

16, 17. UTGD 120242b,a, ventral valve.
Exterior and interior respectively.

18. UTGD 120243, dorsal interior.

D. *Aporthophyla staiti* sp. nov.

All x1.5. All natural moulds except where noted.

19. UTGD 120445, juvenile dorsal interior.

20. UTGD 120400a, holotype ventral interior.

21. UTGD 120434, paratype dorsal interior.
Latex mould.

23. UTGD 120402, paratype dorsal interior, latex mould.

24. UTGD 120407, paratype dorsal interior, latex mould.

25, 32. UTGD 120396, paratype dorsal valve, latex mould. External and posterior views respectively.

26. UTGD 120399, paratype ventral interior.

27. UTGD 120401, paratype ventral interior.

28. UTGD 120409, ventral interior.

29. UTGD 120427, ventral muscle field.

30. UTGD 120437a, paratype dorsal interior, latex mould.

31. UTGD 120410, ventral interior.

33. UTGD 120418b, ventral exterior, latex mould.

34. UTGD 120439, paratype ventral interior.

35. UTGD 120428a, paratype ventral interior.

36. UTGD 120397, paratype dorsal interior.

E. *Sowerbyites vesciseptus* Percival 1979.

All x1.5. All silicified specimens.

37. UTGD 99806, juvenile dorsal interior.

38. UTGD 99805, dorsal interior.

39. UTGD 99808, dorsal interior.

40, 41, 42, 43. UTGD 99813, articulated specimen . Ventral, anterior, lateral and dorsal views respectively.

44, 49, 50, 52. UTGD 99815, articulated specimen. Anterior, dorsal, ventral and lateral views respectively.

45, 46, 47, 51. UTGD 99814, articulated specimen. Ventral, anterior, dorsal and lateral views respectively.

48. UTGD 99804, dorsal interior.

53, 54. UTGD 99807, dorsal interior. External and internal views respectively.

PLATE 11

A. *Sowerbyites vesciseptus* Percival 1979.

All x1.5. All silicified specimens.

1. UTGD 99811, ventral interior.
2. UTGD 99812, ventral interior.
3. UTGD 99803, dorsal interior.

B. *Apatomorpha melrosensis* sp. nov.

All x3. All natural moulds except where noted.

4. UTGD 120322, holotype ventral interior.
5. UTGD 120389, ventral interior.
6. UTGD 120338, paratype ventral interior.
7. UTGD 120376, ventral interior.
8. UTGD 120381, paratype ventral interior.
9. UTGD 120346(I), ventral interior.
10. UTGD 120351, paratype ventral interior.
11. UTGD 120321, ventral interior.
12. UTGD 120320, ventral interior.
13. UTGD 120391, ventral exterior, latex mould.
14. UTGD 120325, paratype dorsal interior.
15. UTGD 120356, paratype dorsal interior, latex mould.
16. UTGD 120358, paratype dorsal interior, latex mould.
17. UTGD 120380(I), paratype dorsal interior, latex mould.

18, 19. UTGD 120331, paratype dorsal interior.

Fig 18, latex mould.

20. UTGD 120380(II), paratype dorsal interior, latex mould.

21. UTGD 120377, dorsal exterior, latex mould.

22. UTGD 120378, paratype dorsal interior, latex mould.

23. UTGD 120374, paratype dorsal exterior, latex mould.

24. UTGD 120336, dorsal exterior, latex mould.

25. UTGD 120363, paratype dorsal exterior, latex mould.

C. Lepidomena pulchra gen. et. sp. nov.

All x1.5 except where noted. All silicified specimens except where noted.

26, 27. UTGD 99911, paratype ventral valve, natural mould. Fig 27, x3.

28, 30, 31. UTGD 99913, paratype articulated specimen. Ventral, enlarged dorsal and dorsal views respectively. Fig 30, x3.5.

29, 32, 33. UTGD 99906, holotype dorsal valve. Oblique, external and internal views respectively.

PLATE 12

A. *Lepidomena pulchra* gen. et. sp. nov.

All x1.5 except where noted. All silicified specimens.

1, 6. UTGD 99930, paratype ventral interior.

Fig 6, x3.5.

2. UTGD 99917, paratype ventral interior.

3. UTGD 99915, ventral interior.

4. UTGD 99916, ventral interior.

5, 9. UTGD 99914, ventral valve.

Internal and external views respectively.

7. UTGD 99907, paratype dorsal interior.

8. UTGD 99908, paratype dorsal interior.

10. UTGD 99923, paratype ventral exterior.

B. *Lepidomena fortimuscula* gen. et. sp. nov.

All x1.5. All silicified specimens.

11, 12. UTGD 99952, paratype ventral interior.

Normal and oblique views respectively.

13, 14. UTGD 99954, paratype ventral interior.

Normal and oblique views respectively.

15. UTGD 99935, holotype dorsal interior.

16. UTGD 99937, paratype dorsal interior.

17. UTGD 99942, paratype dorsal interior.

C. *Leptella corbetti* sp. nov.

All x3 except where noted. All latex moulds.

18. UTGD 97460, paratype articulated specimen. Dorsal view.

19, 23, 28. UTGD 97459, holotype articulated specimen. Posterior, dorsal and lateral views respectively.

20. UTGD 97476, paratype dorsal exterior.

21. UTGD 97457, paratype dorsal exterior.

22. UTGD 97464, paratype ventral interior.

24. UTGD 97477, ventral interior.

25. UTGD 97470, ventral interior.

26. UTGD 97463, paratype ventral interior.

27. UTGD 97475, paratype ventral interior.

29. UTGD 97465, paratype ventral interior.

30. UTGD 97472, paratype dorsal interior.

31. UTGD 97474, paratype dorsal interior.

32. UTGD 97469, paratype dorsal interior.

33. UTGD 97468, paratype dorsal cardinalia. x6.

D. *Leptellina sulcata* sp. nov.

All x3. All silicified specimens.

34, 35, 41. UTGD 99899, holotype ventral valve. Internal, lateral and external views respectively.

36, 42, 43. UTGD 99894, paratype ventral valve. Anterior, internal and external views respectively.

37, 38, 44, 45. UTGD 99893, Ventral Valve. Internal, external, lateral and anterior views respectively.

39, 40. UTGD 99880, paratype dorsal valve.
Internal and external views respectively.

46, 47. UTGD 99882, paratype dorsal valve.
Internal and external views respectively.

PLATE 13

A. *Leptellina sulcata* sp. nov.

All x3. All silicified specimens.

1, 2. UTGD 99879, dorsal valve.

Internal and external views respectively.

3, 4, 5, 6. UTGD 99878, paratype dorsal valve.

External, internal, anterior and lateral views respectively.

B. *Leptellina* sp.

All x2.

7. UTGD 120255, ventral valve interior, natural mould.
8. UTGD 120253, dorsal valve interior, latex mould.

C. *Railtonella scanloni* gen. et. sp. nov.

All x3 except where noted. All natural moulds except where noted.

9. UTGD 99838, paratype ventral interior.
10. UTGD 99837, paratype ventral interior.
11. UTGD 99842, paratype ventral interior.
12. UTGD 99845, ventral interior.

13, 14. UTGD 99839, paratype ventral interior.

Fig 14, latex mould.

15, 16. UTGD 120315, ventral exterior, latex mould.

External and lateral views respectively.

17. UTGD 120304, ventral exterior, latex mould.

18. UTGD 99822(I), paratype dorsal exterior, latex mould.

19. UTGD 99818, paratype dorsal exterior, latex mould.

20. UTGD 99819(I), paratype dorsal exterior, latex mould.

21, 22. UTGD 120293, dorsal interior, latex mould. Fig 21, x6.

23. UTGD 99834, paratype dorsal interior.

24. UTGD 120310a, dorsal interior, latex mould.

25. UTGD 120303, dorsal interior, latex mould.

26. UTGD 99826, paratype dorsal interior.

27. UTGD 99836, paratype dorsal interior, latex mould.

28. UTGD 99825, holotype dorsal interior, latex mould.

29. UTGD 99829, dorsal interior, latex mould.

30. UTGD 99832, dorsal interior, latex mould.

D. Chaganella sp.

all x1.8 except where noted. All specimens silicified.

31. UTGD 99077, ventral interior.

32. UTGD 99075, ventral interior.

33. UTGD 99078, ventral interior.

34, 35, 36. UTGD 99072, dorsal valve. Oblique, internal and enlarged internal views respectively. Fig 36, x4.5.

E. Sowerbyella (Sowerbyella) ?lepta Percival 1979.

All x2. All specimens natural moulds except where noted.

37. UTGD 120850, ventral interior.

38. UTGD 120828(I), ventral interior.

39. UTGD 120809a, ventral interior.

40. UTGD 120826, ventral interior.

41. UTGD 120810, ventral interior.

42. UTGD 120824, ventral interior.

43. UTGD 120833, ventral interior.

44. UTGD 120848(I), ventral exterior, latex mould.

45. UTGD 120835, ventral interior.

46. UTGD 120840, ventral interior.

47. UTGD 120843, ventral interior.

48. UTGD 120821a, ventral exterior, latex mould.

49. UTGD 120811a, dorsal exterior.

50. UTGD 120813, dorsal exterior.

51. UTGD 120823, dorsal exterior, latex mould.

52. UTGD 120807, dorsal exterior.

53. UTGD 120819, dorsal exterior.

54. UTGD 120828(II), dorsal interior.

55. UTGD 120817, dorsal interior.

56. UTGD 120844, dorsal interior.

PLATE 14

A. Sowerbyella (Sowerbyella) ?lepta Percival 1979.

All x2. All natural moulds.

1. UTGD 120820, three dorsal interiors.
2. UTGD 120811b, dorsal interior, counterpart of Plate 13, fig 49.
3. UTGD 120816, dorsal interior.
4. UTGD 120818, dorsal interior.
5. UTGD 120831, dorsal interior.

B. Sowerbyella (Sowerbyella) cf. anticipata Percival 1979.

All x2. All natural moulds except where noted.

6. UTGD 120234, dorsal interior, latex mould.

7, 8. UTGD 120240a, b, dorsal interior and dorsal exterior respectively.

9. UTGD 120238b, ventral interior.
10. UTGD 120237a, ventral interior.
11. UTGD 120241, ventral interior.
12. UTGD 120235, dorsal interior, latex mould.

C. Oepikina banksi sp. nov.

All x1.5. All silicified specimens.

13, 14, 15, 16. UTGD 99779, holotype articulated specimen. Posterior, lateral, ventral and dorsal views respectively.

17, 20, 21, 22. UTGD 99778, paratype articulated specimen. Dorsal, posterior, lateral and ventral views respectively.

18. UTGD 99785, paratype dorsal interior.

19. UTGD 99780, paratype dorsal interior.

23. UTGD 99784, paratype dorsal interior.

24. UTGD 99782, paratype dorsal interior.

25. UTGD 99786, paratype ventral interior.

26. UTGD 99781, paratype dorsal interior.

D. *Dactylogonia rara* sp. nov.

All x3. All silicified specimens.

27, 28, 29. UTGD 99678, paratype articulated specimen. Lateral, posterior and ventral views respectively.

PLATE 15

A. <u>Dactylogonia</u> <u>rara</u> sp. nov.

All x3. All silicified specimens.

1. UTGD 99678, paratype articulated specimen. Dorsal view.

2, 3. UTGD 99670, holotype articulated specimen. Ventral and dorsal view.

4. UTGD 99685, dorsal interior.

5. UTGD 99674, paratype articulated specimen, broken, showing dorsal interior.

6, 7, 8. UTGD 99679, paratype ventral valve. Internal, external and lateral views respectively.

9,12. UTGD 99682, paratype dorsal valve. Fig 9, lateral view, Fig 12, interior stereo pair.

11. UTGD 99683; paratype dorsal valve, stereo pair.

13. UTGD 99680, paratype dorsal interior.

B. <u>Macrocoelia</u> <u>stenomuscula</u> sp. nov.

All x2. All silicified specimens.

14. UTGD 120213, dorsal interior.

15. UTGD 120210, dorsal interior.

16. UTGD 120220, paratype dorsal interior.

17. UTGD 120224, holotype dorsal interior.

18. UTGD 120208, paratype dorsal interior.

19. UTGD 120221, paratype dorsal interior.

20. UTGD 120197, paratype ventral exterior.

21. UTGD 120212, paratype dorsal interior.

22. UTGD 120205, paratype ventral interior.

23. UTGD 120206, paratype ventral interior.

24. UTGD 120207, paratype ventral interior.

25. UTGD 120193, paratype ventral interior.

26. UTGD 120194, ventral interior.

27. UTGD 120195, ventral interior.

C. *Macrocoelia brownae* sp. nov.

28. UTGD 120451, holotype ventral interior.
Silicified specimen, xl.

PLATE 16

A. Macrocoelia brownae sp. nov.

All x1. All silicified specimens.

1, 2, 3. UTGD 120451, holotype ventral valve. External, posterior and lateral views respectively.

4. UTGD 120453, paratype dorsal interior.

5. UTGD 120454, paratype dorsal interior.

6. UTGD 120450, paratype dorsal interior.

7. UTGD 120452, paratype ventral interior.

B. Maakina sp.

8, 9, 10, 11. UTGD 99765, ventral valve, silicified specimen, x2. External, internal, lateral and posterior views respectively.

C. Murinella magna sp. nov.

All x1.5. All silicified specimens.

12. UTGD 120245, paratype ventral interior.

13. UTGD 99792, ventral interior.

14. UTGD 99789, paratype ventral interior.

15. UTGD 99788, paratype articulated specimen. Dorsal view.

16. UTGD 99802, paratype articulated specimen. Dorsal view.

17. UTGD 99800, ventral exterior.

18. UTGD 99796, articulated specimen. Dorsal view.

19. UTGD 99799, articulated specimen. Dorsal view.

20. UTGD 99787, holotype articulated specimen. Dorsal view.

21. UTGD 99790, paratype dorsal interior.

PLATE 17

A. *Murinella magna* sp. nov.

All x1.5. All silicified specimens.

1. UTGD 120246, paratype dorsal interior.
2. UTGD 99798, articulated specimen. Dorsal view.
3. UTGD 99794, dorsal interior.
4. UTGD 99795, ventral interior.
5. UTGD 99791, paratype dorsal interior.
6. UTGD 120250, paratype dorsal interior.

B. *Bellimurina* aff. *compressa* Cooper 1956.

All x1.8. All silicified specimens.

7. UTGD 99691, ventral interior.
8. UTGD 99690, articulated specimen. Ventral view.
9. UTGD 99695, ventral muscle field.

10, 11. UTGD 99689, articulated specimen. Dorsal and posterior views respectively.

12, 13. UTGD 99686, juvenile ventral valve. Internal and external views respectively.

14, 15. UTGD 99688, two separate valves, originally articulated. Ventral exterior and dorsal interior respectively.

16. UTGD 99687, dorsal interior.

C. Strophomena burretti sp. nov.

All x1.5 except where noted. All specimens silicified.

17, 18, 19. UTGD 99997, holotype articulated specimen. Ventral, dorsal and enlarged posterior views respectively. Fig 19, x2.3.

20. UTGD 99998, paratype ventral interior.

21. UTGD 99999, paratype ventral interior.

22. UTGD 120101, paratype ventral interior.

23. UTGD 120121, paratype ventral interior.

24. UTGD 120124, paratype dorsal interior.

25. UTGD 120126, paratype dorsal interior.

26. UTGD 120128, paratype dorsal interior.

27. UTGD 120130, paratype dorsal interior.

D. Strophomena cf. oklahomensis Cooper 1956.

All x1.5. All silicified specimens.

28, 29. UTGD 99986, ventral valve. Internal and external views respectively.

30. UTGD 99972, dorsal interior.

PLATE 18

A. *Strophomena* cf. *oklahomensis* Cooper 1956.

All x1.5. All silicified specimens.

1, 2. UTGD 99980, ventral valve.

Internal and external views respectively.

3. UTGD 99976, dorsal interior.

4. UTGD 99986, ventral interior.

5. UTGD 99982, ventral exterior.

B. *Holtedahlina* sp.

All x2. All silicified specimens.

6. UTGD 120176, ventral interior.

7. UTGD 120178, ventral interior.

8. UTGD 120190, dorsal interior.

C. ?*Strophomena* sp.

All x1. All silicified specimens.

9. UTGD 99774, ventral interior.

10. UTGD 99771, dorsal interior.

D. *Teratelasmella plicata* gen. et. sp. nov.

All x3. All silicified specimens.

11, 12, 15, 16, 17. UTGD 99641, holotype articulated specimen. Dorsal, ventral, posterior, lateral and anterior views.

13, 14, 18. UTGD 99642, paratype articulated specimen. Dorsal, ventral and anterior views respectively.

19, 20, 21, 22. UTGD 99640, paratype articulated specimen. Ventral, dorsal, lateral and anterior views respectively.

23, 24, 25. UTGD 99645, paratype articulated specimen. Dorsal, ventral and anterior views respectively.

26, 27. UTGD 99646, articulated specimen. Ventral and dorsal views respectively.

28. UTGD 99644, paratype articulated specimen. Ventral view.

29. UTGD 99648, paratype ventral interior.

30. UTGD 99647, paratype ventral interior.

31. UTGD 99654, ventral interior.

32, 38. UTGD 99668, paratype articulated specimen, broken showing dorsal interior. Anterior and ventral views respectively.

33. UTGD 99655, ventral interior.

34. UTGD 99666, dorsal interior.

35. UTGD 99665, dorsal interior.

36. UTGD 99667, dorsal interior.

37. UTGD 99662, dorsal interior.

39. UTGD 99664, paratype dorsal interior.

40. UTGD 99649, paratype ventral interior.

PLATE 19

A. *Teratelasmella plicata* gen. et. sp. nov.

All x3. All silicified specimens.

1, 2, 3. UTGD 99669, paratype dorsal valve. Internal, lateral and anterior views respectively.

4. UTGD 99661, dorsal interior.

B. Oepikinid indet.

All x2.5 except where noted. All silicified specimens.

5. UTGD 99714, ventral interior.

6. UTGD 99712, ventral interior. x2.

7, 8. UTGD 99720, dorsal valve. Internal and external views respectively.

9, 10. UTGD 99709, articulated specimen. Dorsal and ventral views respectively.

11. UTGD 99717, dorsal interior.

12. UTGD 99718, dorsal interior.

13, 14. UTGD 99710, articulated specimen. Dorsal and ventral views respectively.

15. UTGD 99713, ventral interior.

C. *Maydenella asymmetrica* gen. et. sp. nov.

All x2. All specimens silicified.

16. UTGD 99723, dorsal exterior.

17, 23. UTGD 99732, paratype articulated specimen. Dorsal and ventral views respectively.

18, 19, 20, 21. UTGD 99748, holotype articulated specimen. Ventral, dorsal, posterior and lateral views.

22. UTGD 99739, paratype dorsal cardinalia.

24. UTGD 99734, dorsal interior.

25. UTGD 99735, paratype dorsal interior.

26. UTGD 99751, dorsal interior.

27. UTGD 99730, paratype ventral interior.

28. UTGD 99737, paratype ventral interior.

29. UTGD 99754, paratype ventral interior.

30. UTGD 99722, dorsal interior.

31. UTGD 99750, dorsal exterior.

32. UTGD 99762, articulated specimen, interior.

33, 34. UTGD 99721, paratype dorsal valve. Exterior and interior views respectively.

35. UTGD 99755, paratype dorsal exterior.

36. UTGD 99746, dorsal exterior.

D. Rhynchotrema bailliei sp. nov.

37, 38, 39, 40. UTGD 120473, articulated specimen, silicified. Lateral, anterior, dorsal and ventral views respectively. x2.

PLATE 20

A. Rhynchotrema bailliei sp. nov.

All x2. All silicified specimens.

1, 2, 3. UTGD 120455, holotype articulated specimen. Lateral, anterior and ventral views respectively.

4, 5. UTGD 120458, paratype articulated specimen. ventral and anterior views respectively.

6. UTGD 120481, paratype dorsal interior. Cardinal process obscured by adhering silica.

7, 8, 9, 10. UTGD 120456, paratype articulated specimen. Dorsal, ventral, anterior and lateral views.

11. UTGD 120465, paratype dorsal interior.

B. Rhynchotrema ponderosa

All x1.8 except where noted. All silicified specimens.

12. UTGD 120503, paratype ventral interior.

13, 14, 15, 16. UTGD 120502, paratype articulated specimen. Anterior, lateral, ventral and dorsal views respectively.

17, 20, 21, 22. UTGD 120501, holotype articulated specimen. Anterior, dorsal, ventral and lateral views respectively.

18, 19, 23, 24. UTGD 120504, paratype articulated specimen. Anterior, ventral, lateral and dorsal views respectively.

25, 26. UTGD 120507, paratype dorsal interior.
Fig 26, enlarged dorsal cardinalia, x5.

27, 32, 34. UTGD 120508, paratype dorsal valve.
Internal, external views and enlargement of cardinalia, respectively. Fig 34, x5.

28, 29, 33. UTGD 120509, paratype dorsal valve.
Internal, external views and enlargement of cardinalia, respectively. Fig 33, x5.

30, 31. UTGD 120506, paratype dorsal valve.
Internal and external views respectively.

35. UTGD 120514, paratype dorsal cardinalia x5.

36, 37. UTGD 120511, paratype dorsal interior.
Fig 37, enlargement of cardinalia, x5.

38, 39. UTGD 120510, paratype dorsal valve.
External and internal views respectively.

C. *Rhynchotrema crossi* sp. nov.

All x1.8. All silicified specimens.

40. UTGD 120552, paratype ventral interior.

41, 42, 43, 44. UTGD 120557, paratype articulated specimen. Anterior, lateral, dorsal and ventral views respectively.

PLATE 21

A. *Rhynchotrema crossi* sp. nov.

All x1.8 except where noted. All silicified specimens.

1, 2, 3, 4. UTGD 120550, paratype articulated specimen. Anterior, ventral, lateral and dorsal views respectively.

5, 15, 17, 18, 19. UTGD 120554, holotype articulated specimen. External detail, dorsal, ventral, anterior and lateral views respectively. Fig 5, x8.5.

6, 7, 8, 9. UTGD 120545, paratype articulated specimen. Ventral, anterior, dorsal and lateral views respectively.

10. UTGD 120561, paratype articulated specimen. Internal view.

11, 12, 13. UTGD 120556, paratype articulated specimen. Lateral, anterior and dorsal views respectively.

14. UTGD 120560, paratype articulated specimen. Internal view.

16, 20, 21, 22. UTGD 120546, paratype articulated specimen. Ventral, lateral, anterior and dorsal views respectively.

B. <u>Rhynchotrema</u> ?<u>iowense</u> Wang 1949

All x3.5. All silicified specimens.

23, 24, 25, 26. UTGD 120533, juvenile articulated specimen. Lateral, anterior, ventral and dorsal views respectively. This specimen appears to have its pedicle preserved.

27, 35. UTGD 120539, dorsal valve. Lateral and anterior views respectively.

28, 30, 31, 32. UTGD 120527, articulated specimen. Lateral, ventral, anterior and dorsal views respectively.

29, 33, 34, 36. UTGD 120517, articulated specimen. Lateral, dorsal, ventral and anterior views respectively.

PLATE 22

A. Rhynchotrema ?iowense Wang 1949.

All x3.5. All silicified specimens.

1. UTGD 120539, dorsal interior.

2, 3, 5, 6. UTGD 120525, articulated specimen. Anterior, dorsal, ventral and lateral views respectively.

4, 7, 8, 10. UTGD 120531, ventral valve. Anterior, lateral, external and internal views respectively.

9, 11, 12, 13. UTGD 120530, ventral valve. Lateral, internal, anterior and external views respectively.

B. Azamella rotunda gen. et. sp. nov.

All x3.5. All silicified specimens.

14, 15, 16, 17. UTGD 120572, juvenile articulated specimen. Lateral, anterior, dorsal and ventral views respectively.

18, 19, 20, 21. UTGD 120569, juvenile articulated specimen. Lateral, anterior, ventral and dorsal views respectively.

PLATE 23

Azamella rotunda gen. et. sp. nov.

All x3.5. All silicified specimens.

1, 2, 3, 4. UTGD 120568, paratype articulated specimen. Lateral, anterior, ventral and dorsal views respectively.

5, 8. UTGD 120587, paratype ventral valve. Oblique and normal views respectively.

6, 7, 9, 10. UTGD 120566, holotype articulated specimen. Anterior, ventral, lateral and dorsal views respectively.

11, 12, 15. UTGD 120565, paratype articulated specimen. Lateral, anterior and ventral views respectively.

13, 14, 18. UTGD 120564, paratype articulated specimen. Lateral, anterior and ventral views respectively.

16. UTGD 120598, paratype dorsal interior.

17. UTGD 120599, paratype dorsal interior. Anterior view.

PLATE 24

A. Azamella sulcata gen. et. sp. nov.

All x1.8 except where noted. All specimens silicified.

1. UTGD 120640, ventral exterior.

2, 3, 9, 17, 22. UTGD 120637, ventral valve. Internal, anterior, lateral, internal oblique and exterior views respectively.

4, 5, 6, 11. UTGD 120643, paratype ventral valve. Lateral, internal, external and anterior views.

7, 8, 10. UTGD 120639, ventral valve. Lateral, external and anterior views respectively.

12, 13, 18. UTGD 120641, paratype ventral valve. External, anterior and enlarged anterior views respectively. Fig 18, x4.5.

14, 15, 16, 19. UTGD 120605, holotype articulated specimen. Dorsal, ventral, lateral and anterior views.

20, 21, 23, 24. UTGD 120616, paratype articulated specimen. Lateral, anterior, ventral and dorsal views respectively.

25, 26, 27, 28. UTGD 120611, paratype articulated specimen. Anterior, ventral, lateral and dorsal views respectively.

B. *Tasmanella nova* gen. et. sp. nov.

All x1.8. All specimens silicified.

29, 30, 31, 32. UTGD 120675, holotype dorsal valve.
Internal, external, lateral and anterior oblique views respectively.

33, 34. UTGD 120693, dorsal valve.
External and lateral views respectively.

35, 36, 37. UTGD 120676, paratype ventral valve.
External, lateral and posterior views.

38, 39. UTGD 120678, paratype ventral valve.
Lateral and external views respectively.

40. UTGD 120681, paratype ventral interior.

41. UTGD 120680, ventral interior.

42. UTGD 120679, ventral interior.

43. UTGD 120683, paratype ventral interior.

44. UTGD 120682, ventral interior.

45. UTGD 120688, paratype ventral interior.

C. *Cryptospira intraplicata* gen. et. sp. nov.

46, 47, 48. UTGD 120798, paratype ventral exterior, latex mould. Normal, lateral and posterior views respectively. x2.5.

PLATE 25

A. <u>Cryptospira</u> <u>intraplicata</u> gen. et. sp. nov.

All x2.5. All natural moulds unless otherwise noted.

1. UTGD 120795, paratype dorsal exterior, latex mould.
2. UTGD 120792, dorsal exterior.
3. UTGD 120793(III), paratype dorsal exterior.
4. UTGD 120787, paratype ventral interior.
5. UTGD 120796, paratype dorsal interior.
6. UTGD 120779, dorsal interior.
7. UTGD 120783, dorsal interior.
8. UTGD 120780(III), dorsal interior.
9. UTGD 120775, paratype dorsal interior.
10. UTGD 120786, dorsal interior.
11. UTGD 120776, dorsal interior.
12. UTGD 120790, ventral interior.
13. UTGD 120793(I,II), two paratype dorsal interiors.
14. UTGD 120794, ventral interior.
15. UTGD 120777, ventral interior.
16. UTGD 120789, paratype ventral interior.
17. UTGD 120778, paratype ventral interior.
18. UTGD 120781, ventral interior.
19. UTGD 120780(I), holotype ventral interior.

B. *Hallina inconspicua* sp. nov.

All x6. All silicified specimens.

20, 21, 22, 23. UTGD 120697, holotype articulated specimen. Ventral, dorsal, anterior and lateral views respectively.

24, 25, 30, 31. UTGD 120701, paratype articulated specimen. Ventral, dorsal, anterior and lateral views respectively.

26, 27, 28, 29. UTGD 120699, paratype articulated specimen. Dorsal, anterior, lateral and ventral views respectively.

32, 33, 34, 35. UTGD 120698, paratype articulated specimen. Lateral, dorsal, ventral and lateral views respectively.

36. UTGD 120708, articulated specimen, view with ventral valve, partly removed to expose preserved brachidium.

37. UTGD 120710, small articulated specimen, ventral view.

PLATE 26

A. *Hallina inconspicua* sp. nov.

1, 2, 3, 4. UTGD 120700, paratype articulated specimen, silicified. Dorsal, anterior, lateral and ventral views respectively. Silicified specimen, x6.

B. *Protozyga aseptata* sp. nov.

All x6 except where noted. All specimens silicified.

5, 6, 7, 8. UTGD 120719, paratype articulated specimen. Ventral, lateral, anterior and dorsal views respectively.

9, 10, 11, 14. UTGD 120715, holotype articulated specimen. Anterior, dorsal, ventral and lateral views respectively.

12, 13. UTGD 120723, paratype ventral interior. Anterior oblique and normal views respectively. Fig 12, x9.

PLATE 1

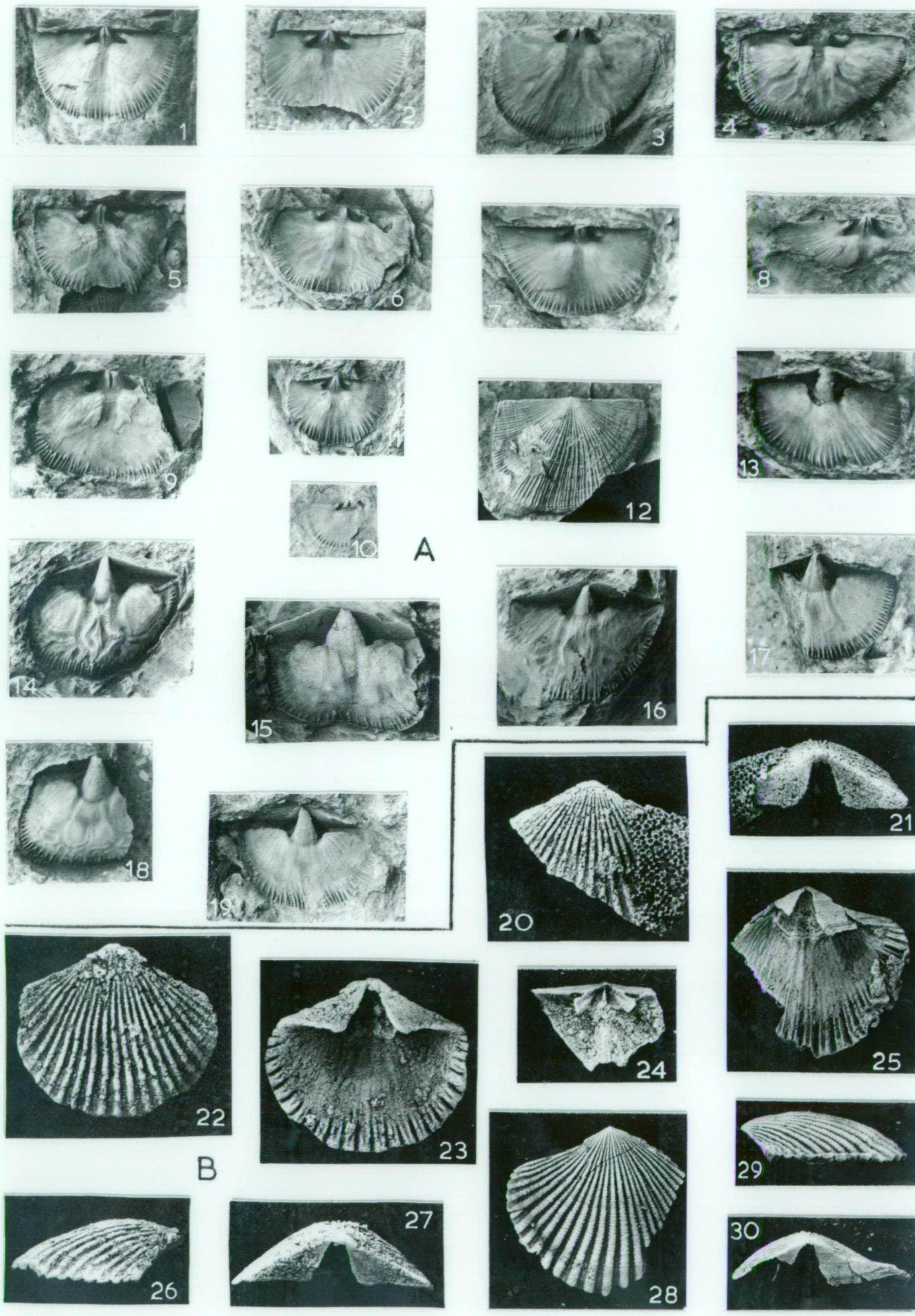
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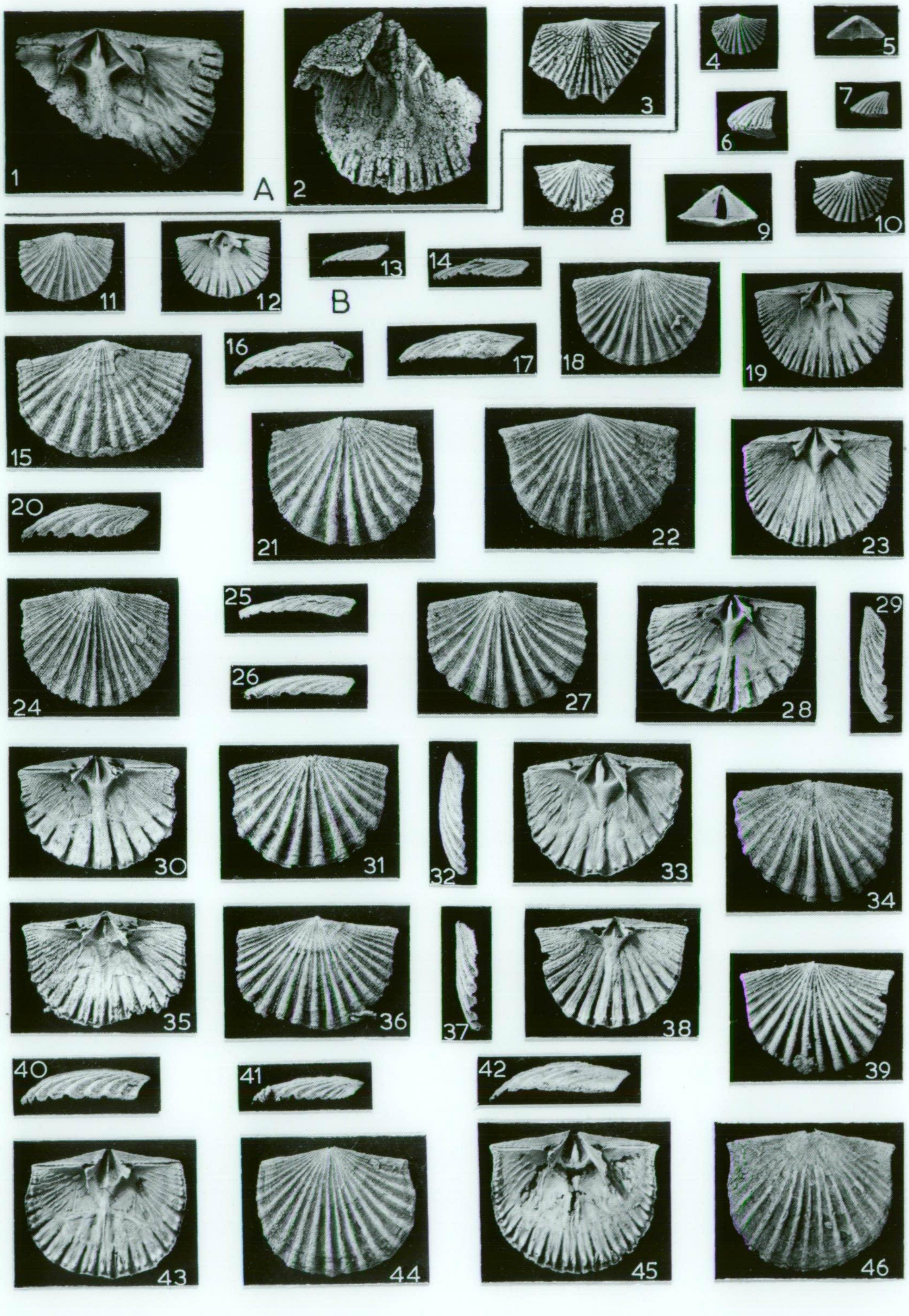
PLATE 2



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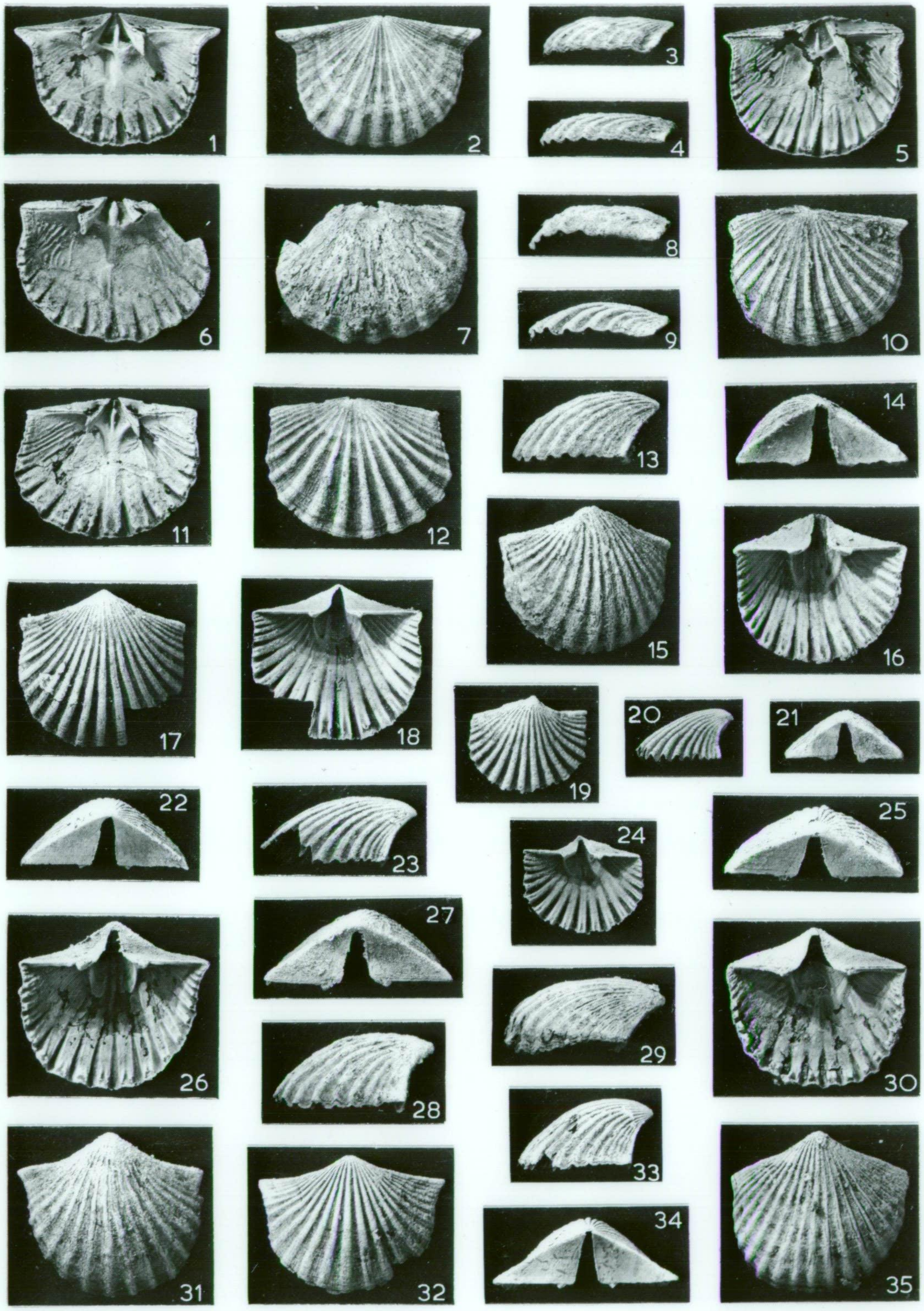
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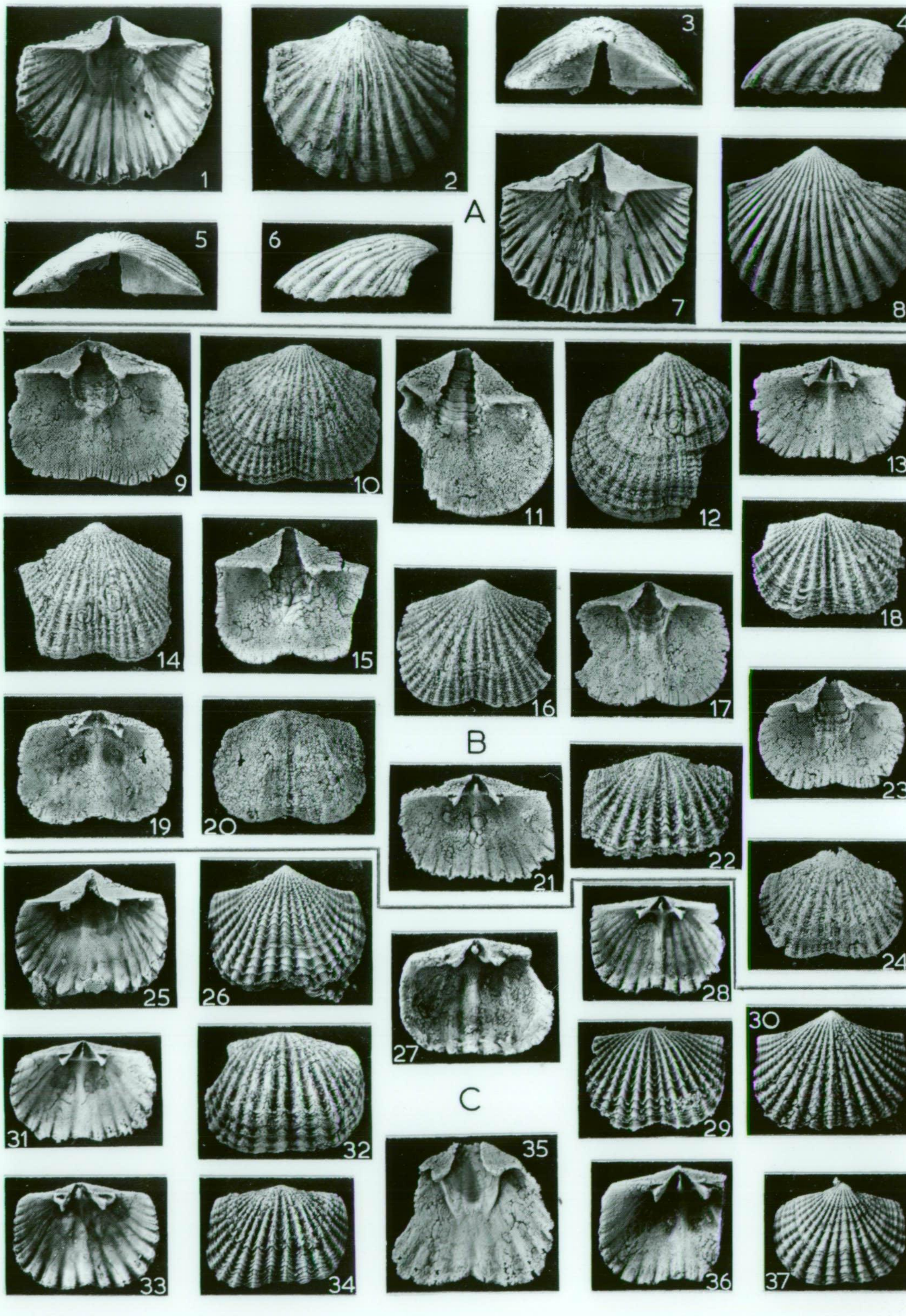
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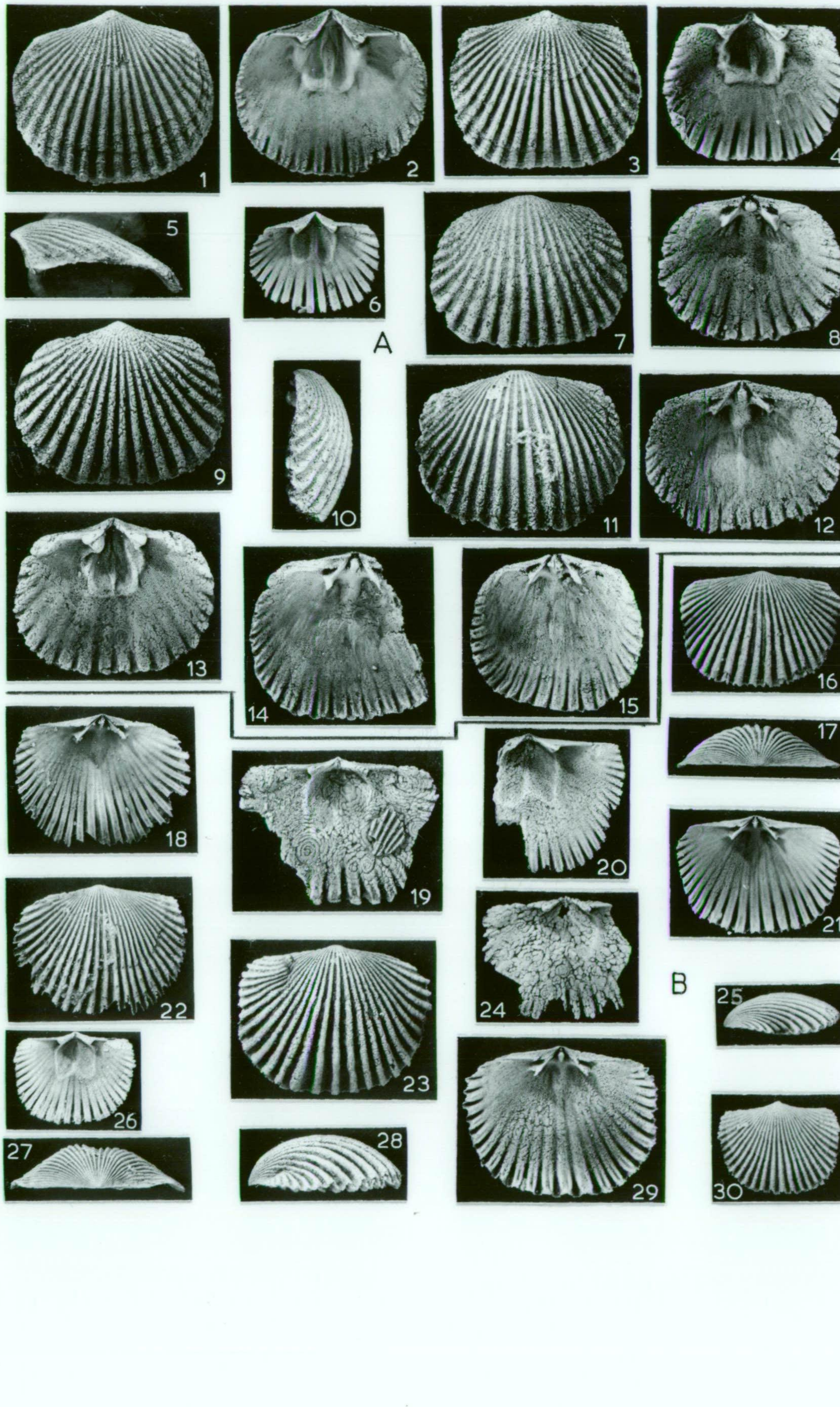
PLATE 5



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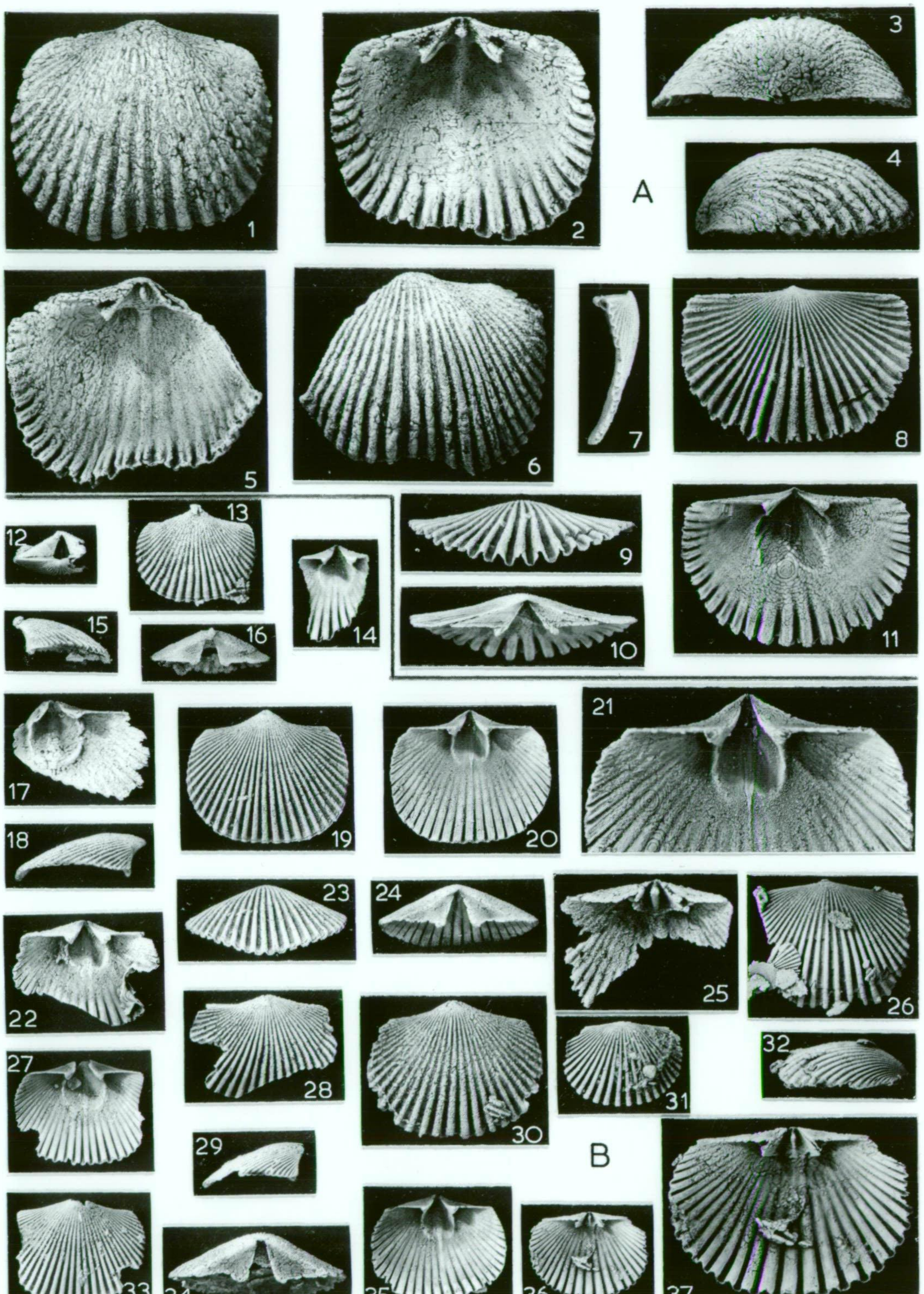
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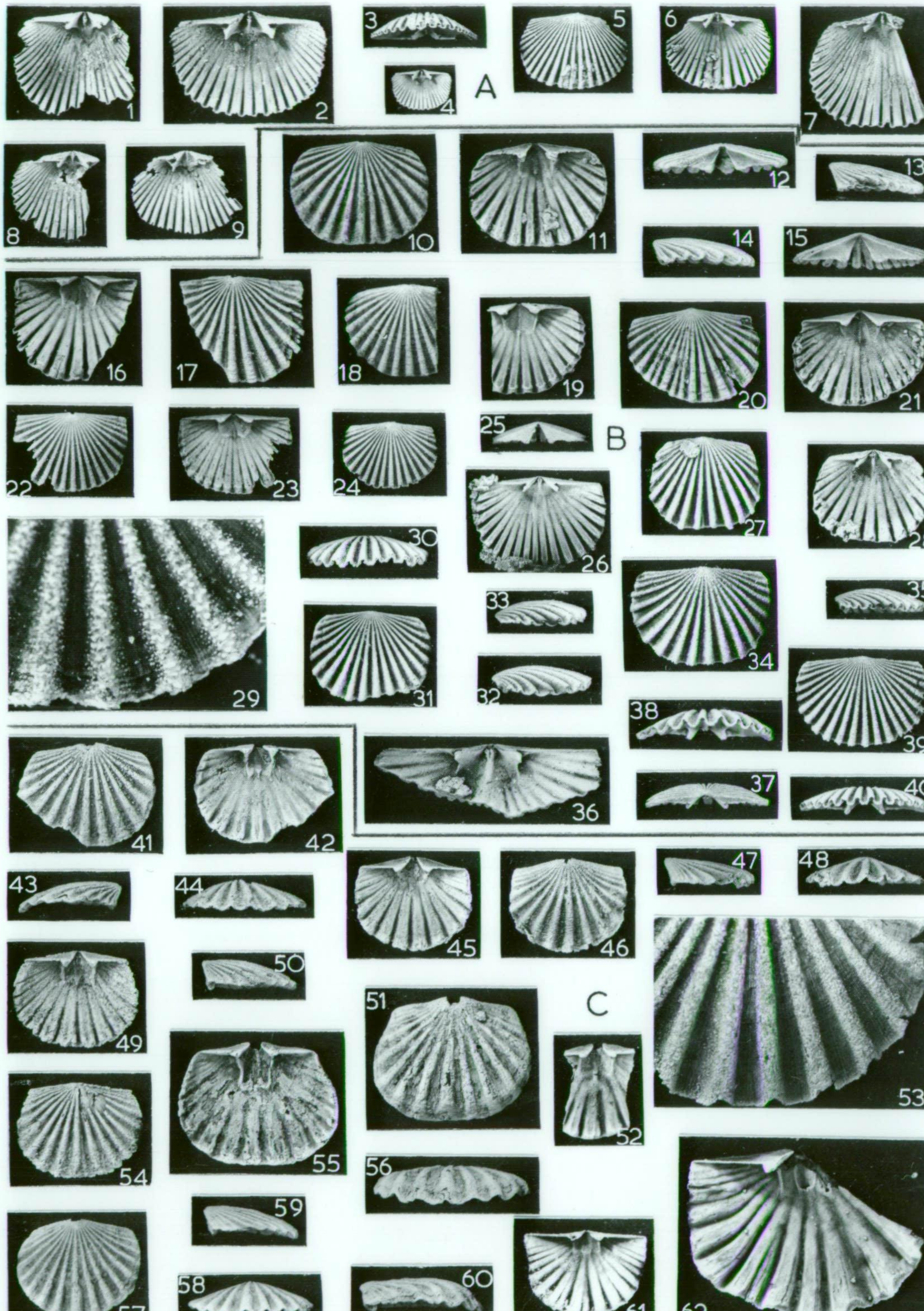
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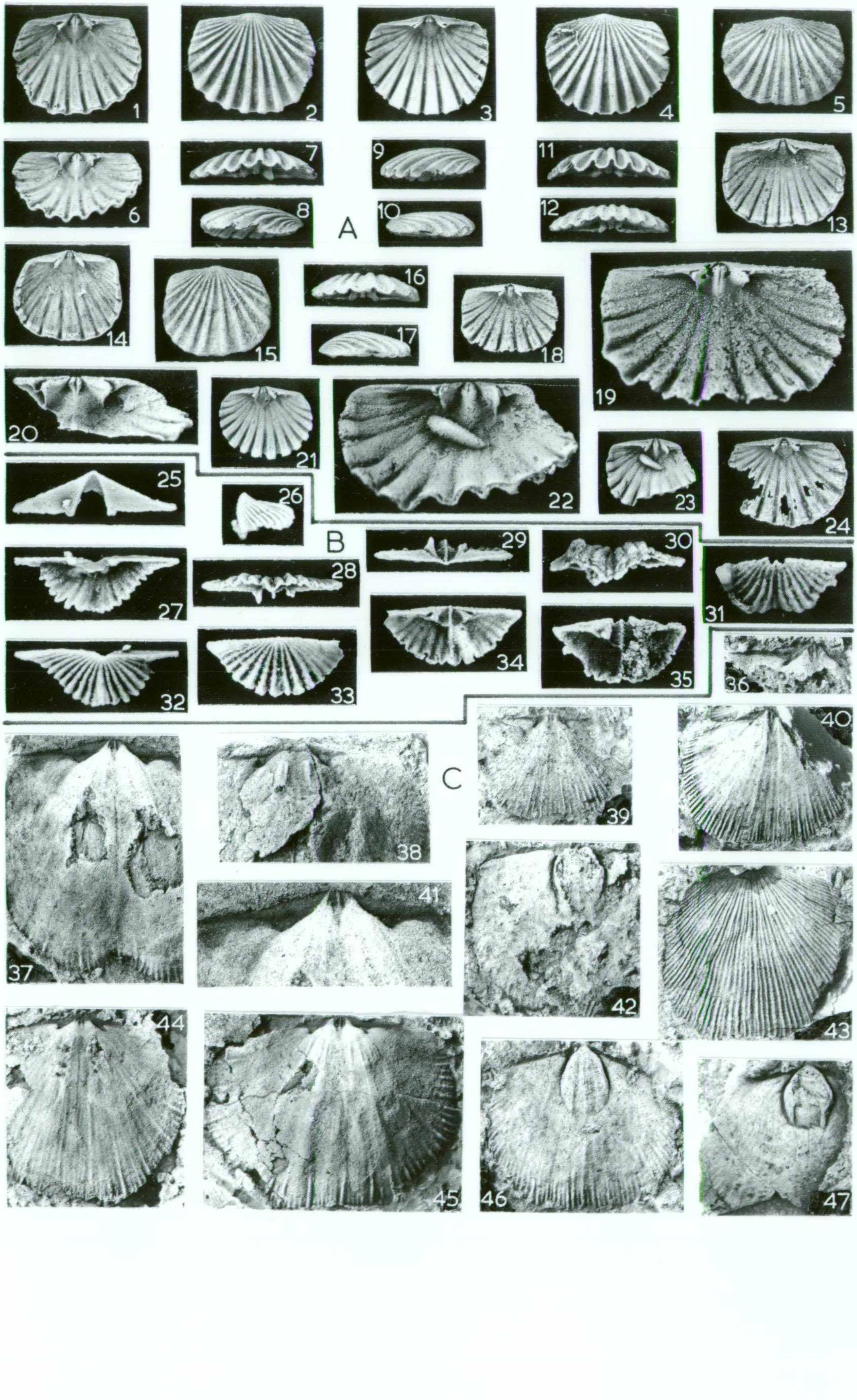
PLATE 8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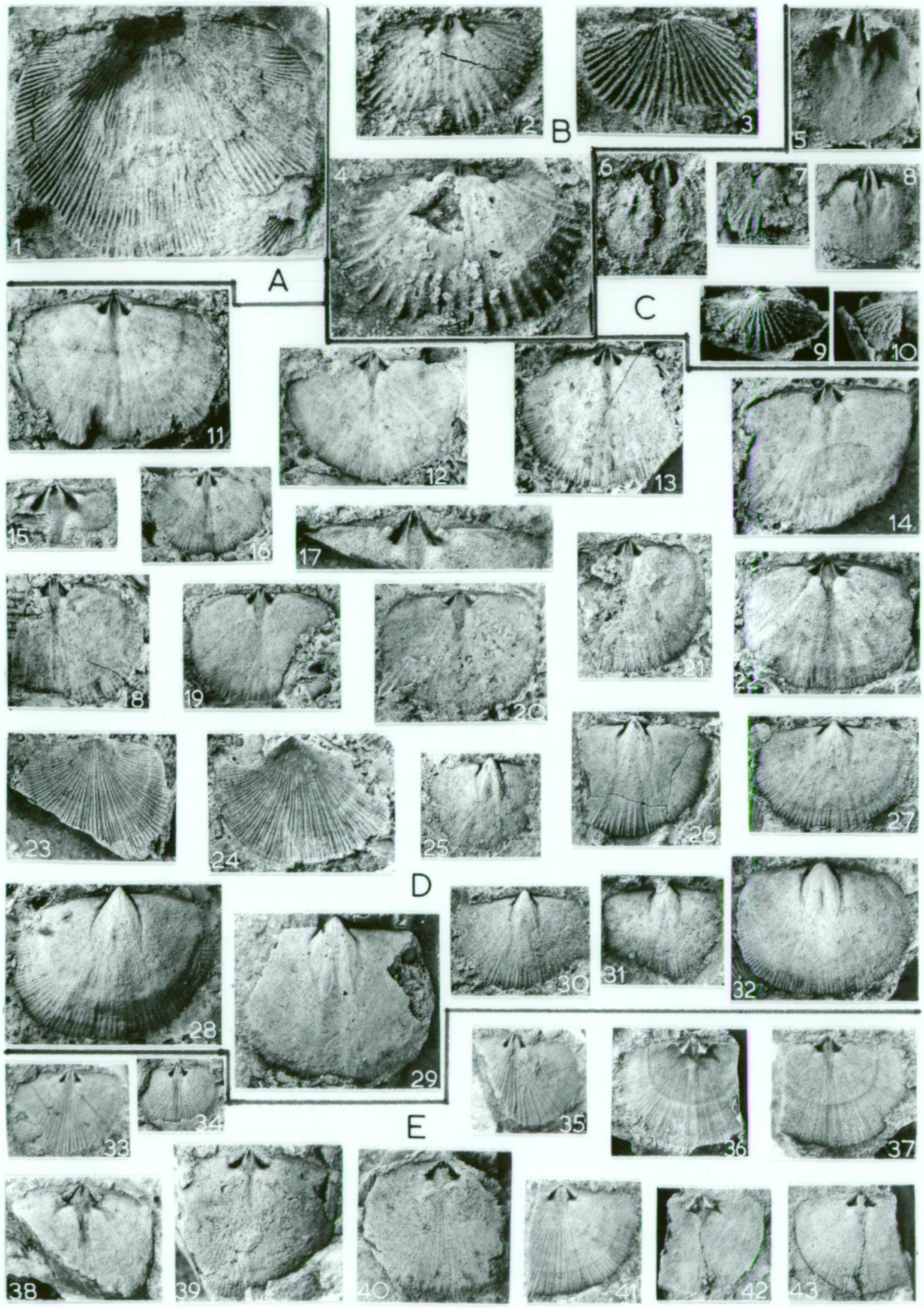
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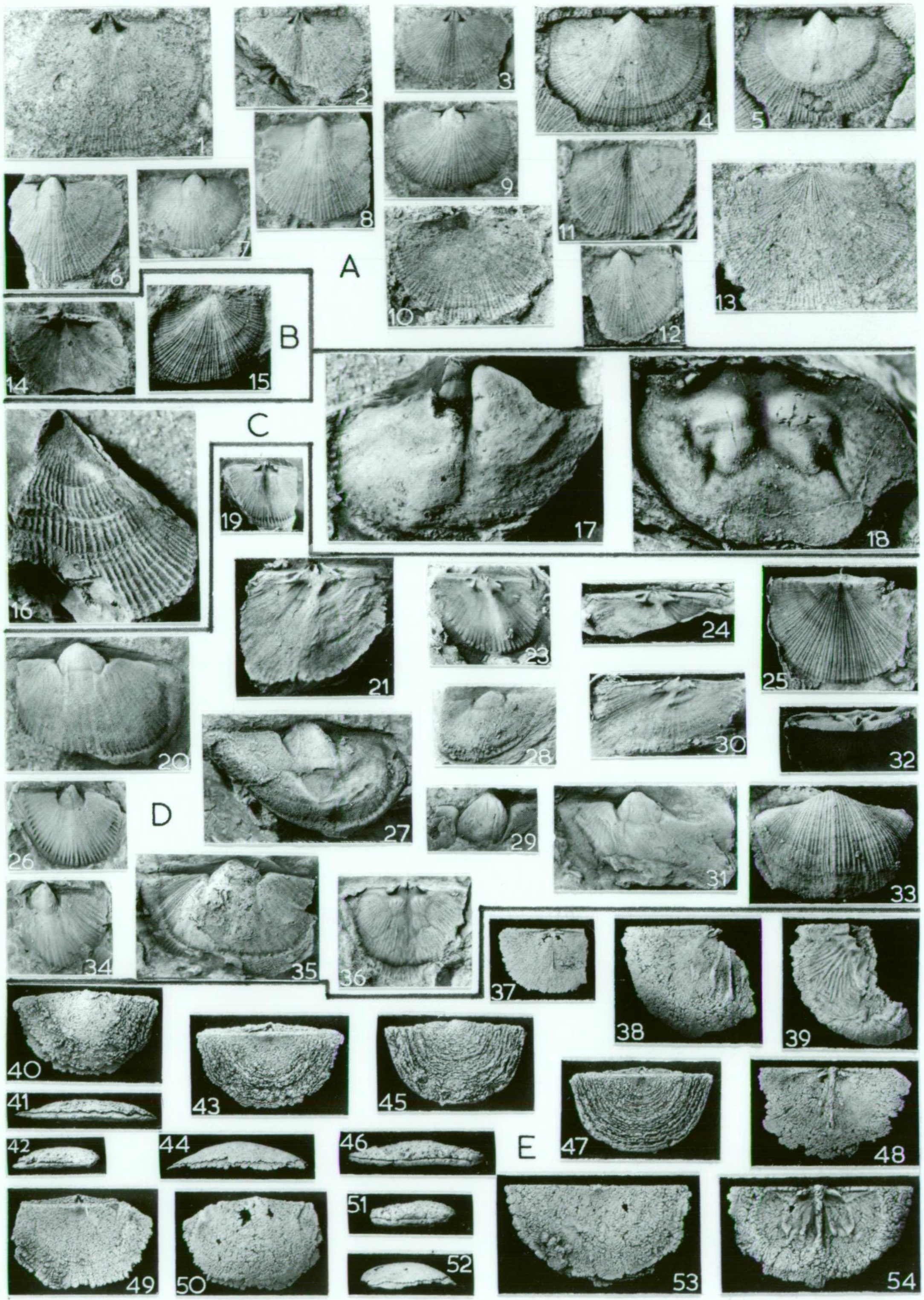
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PLATE 11


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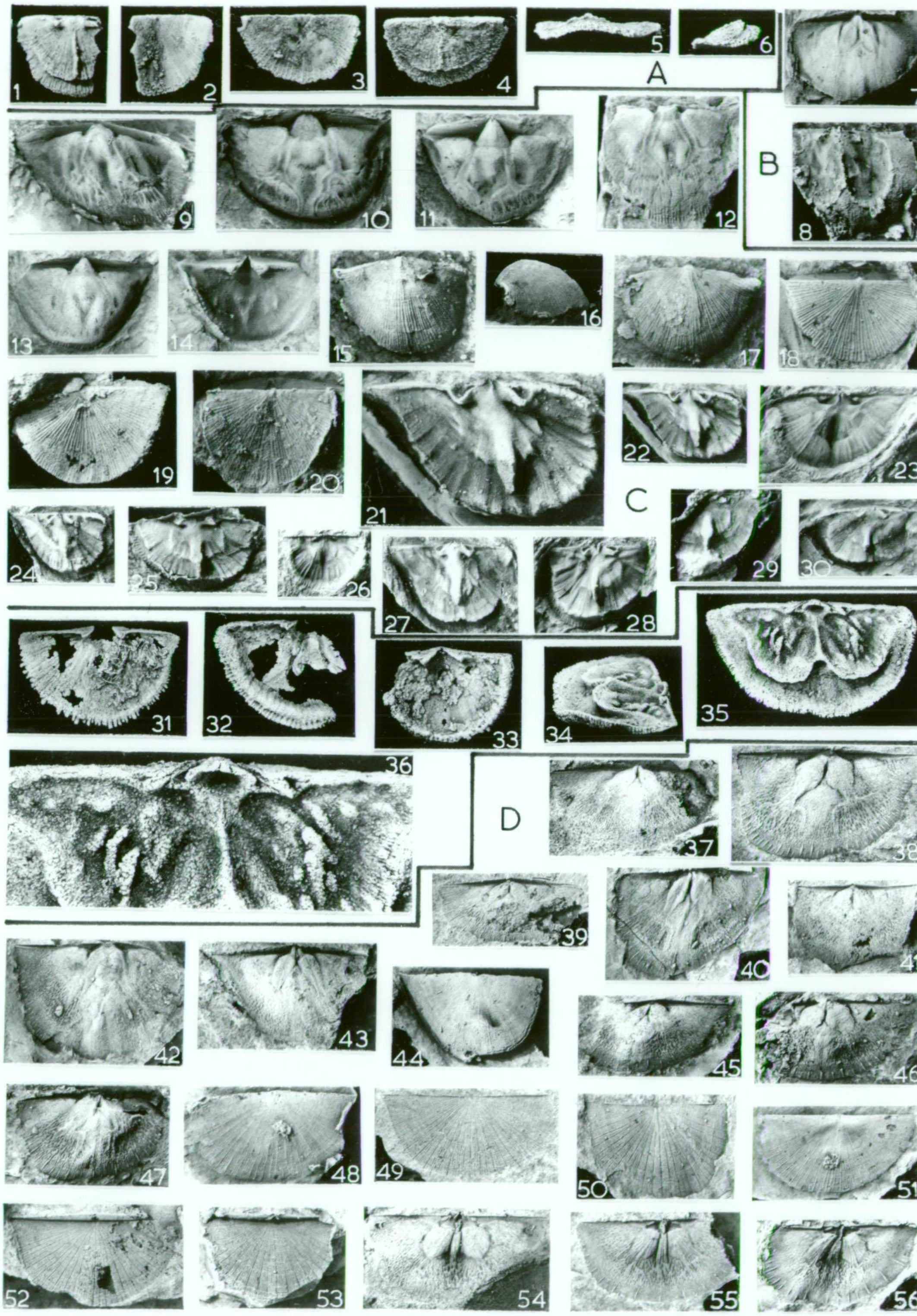
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PLATE 14

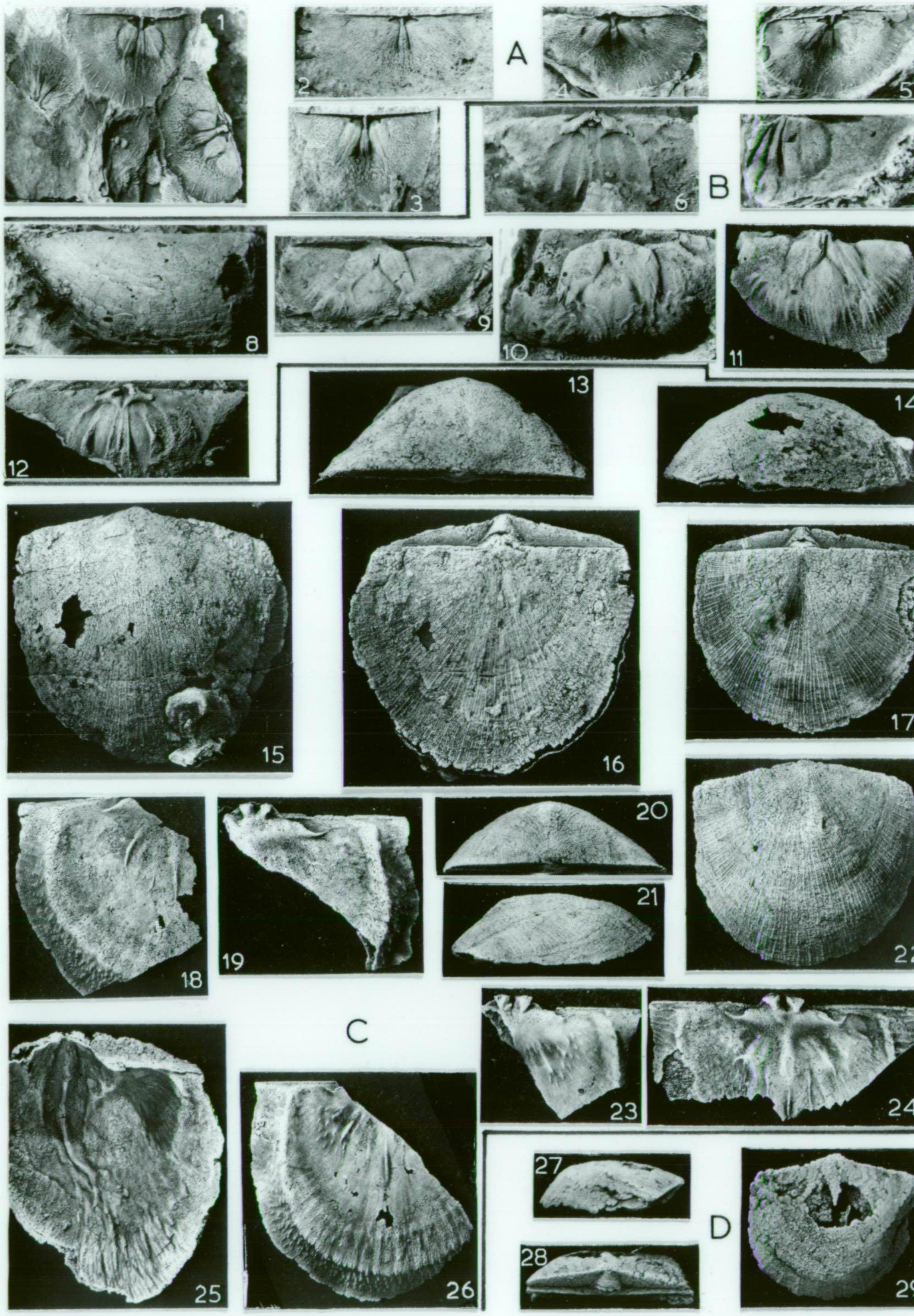

PLATE 15

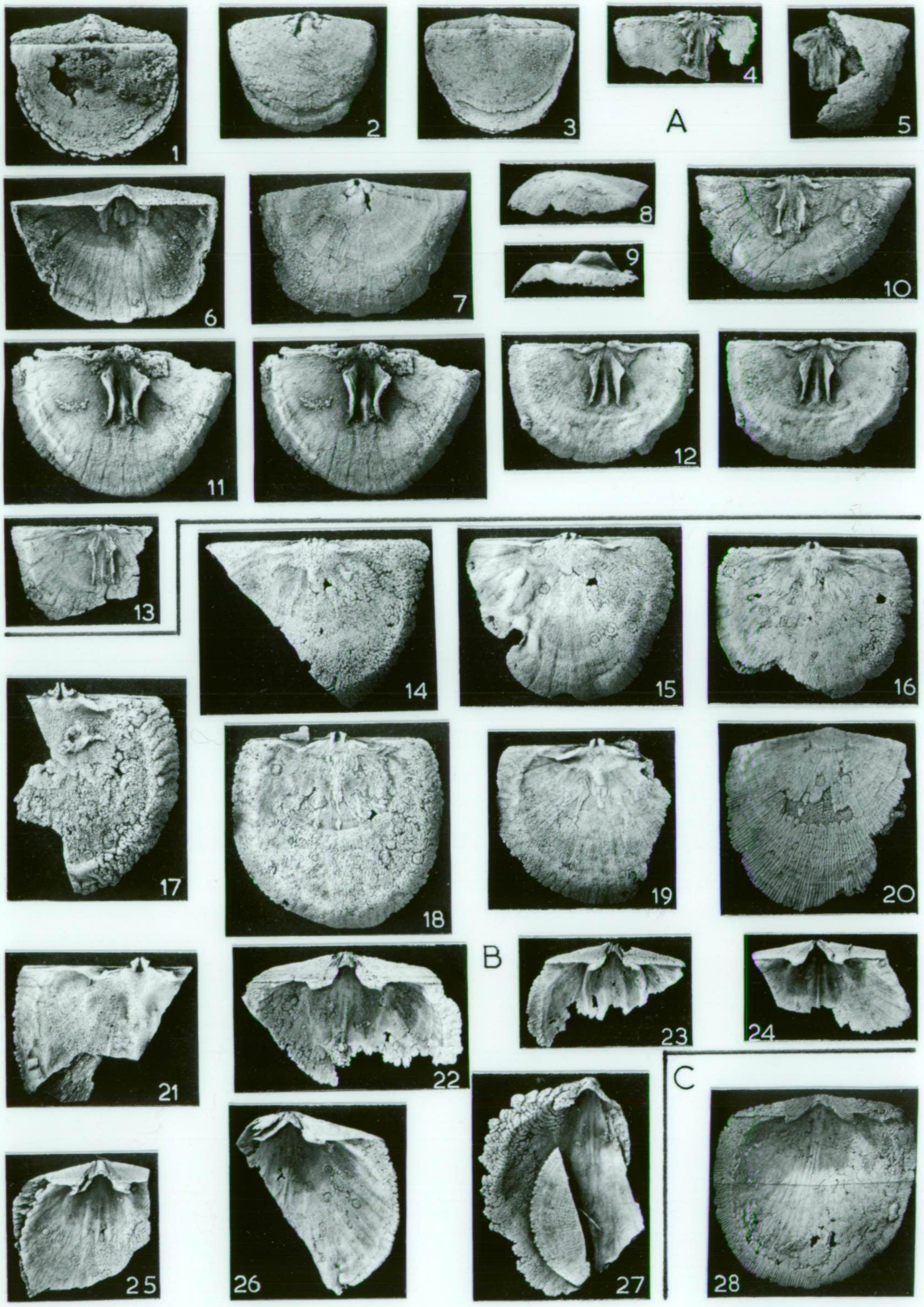
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PLATE 18


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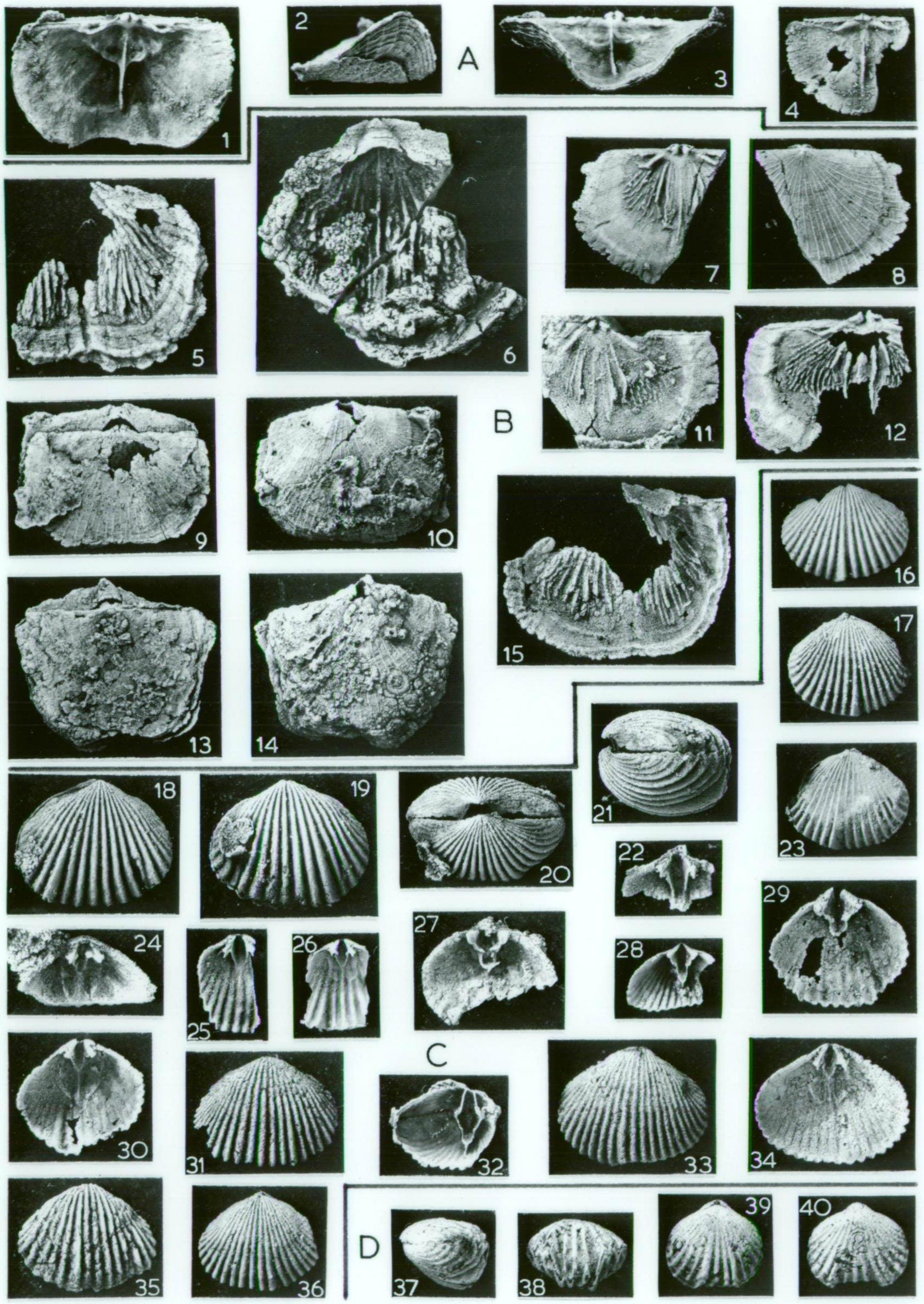
PLATE 19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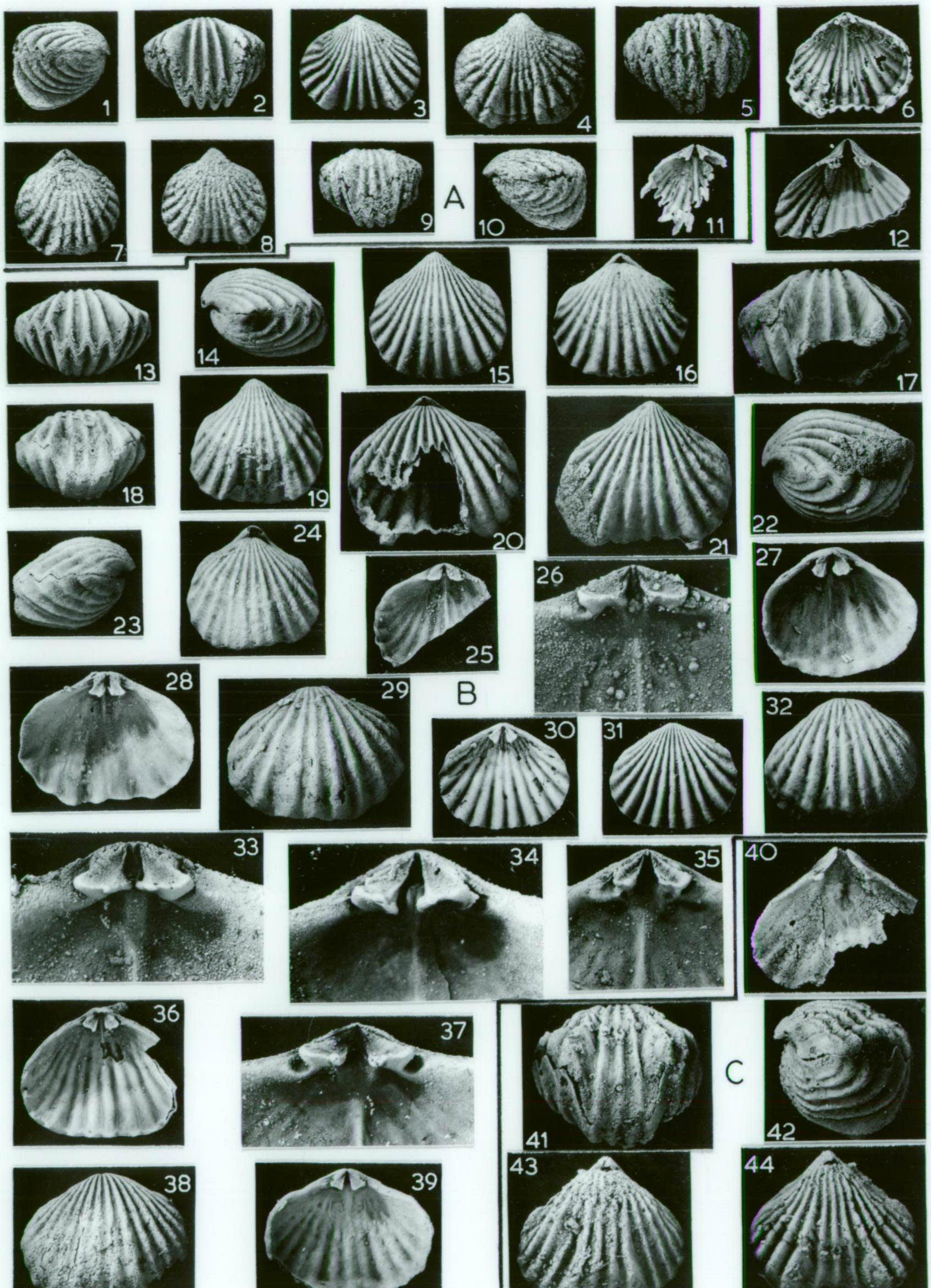
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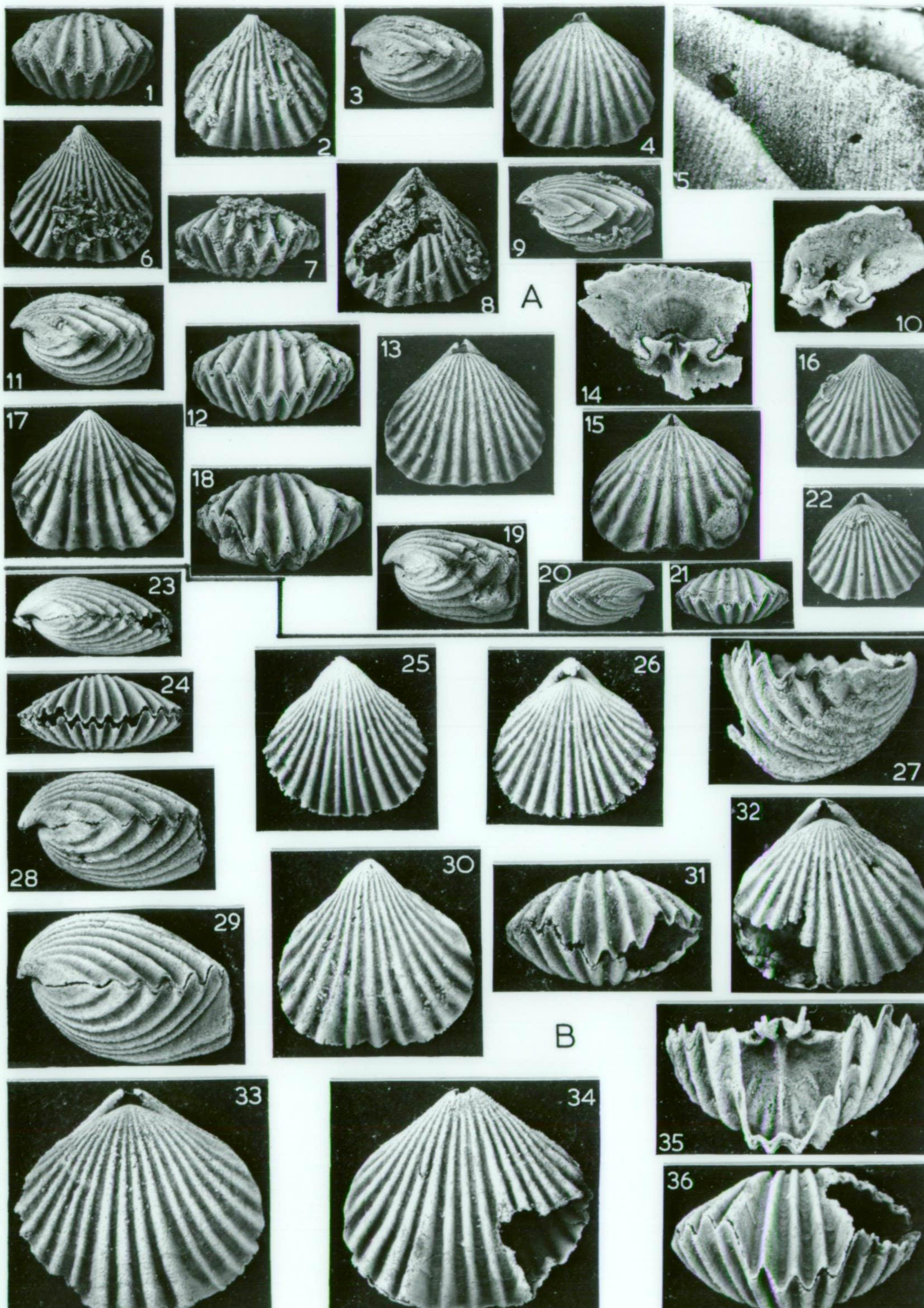
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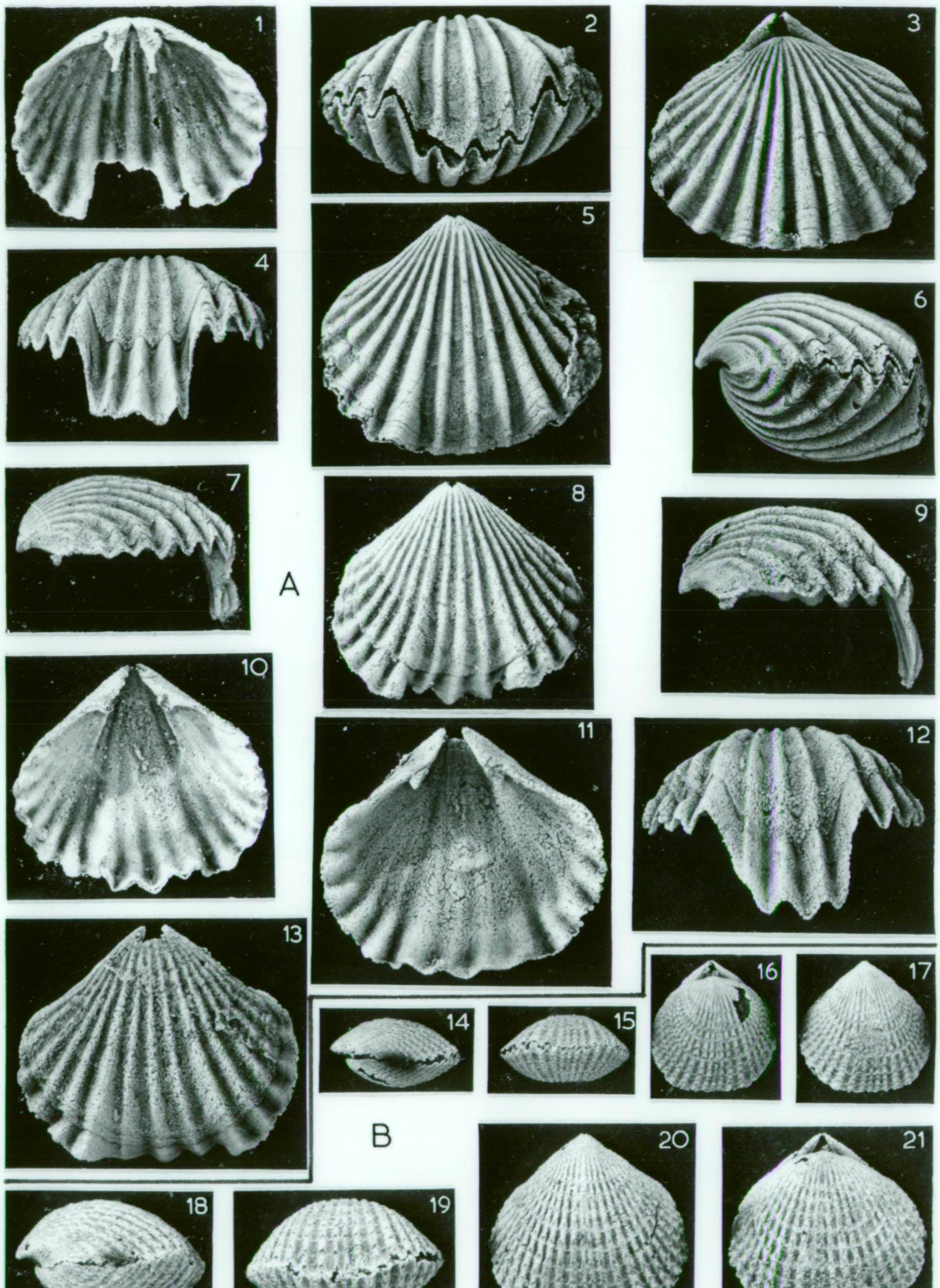
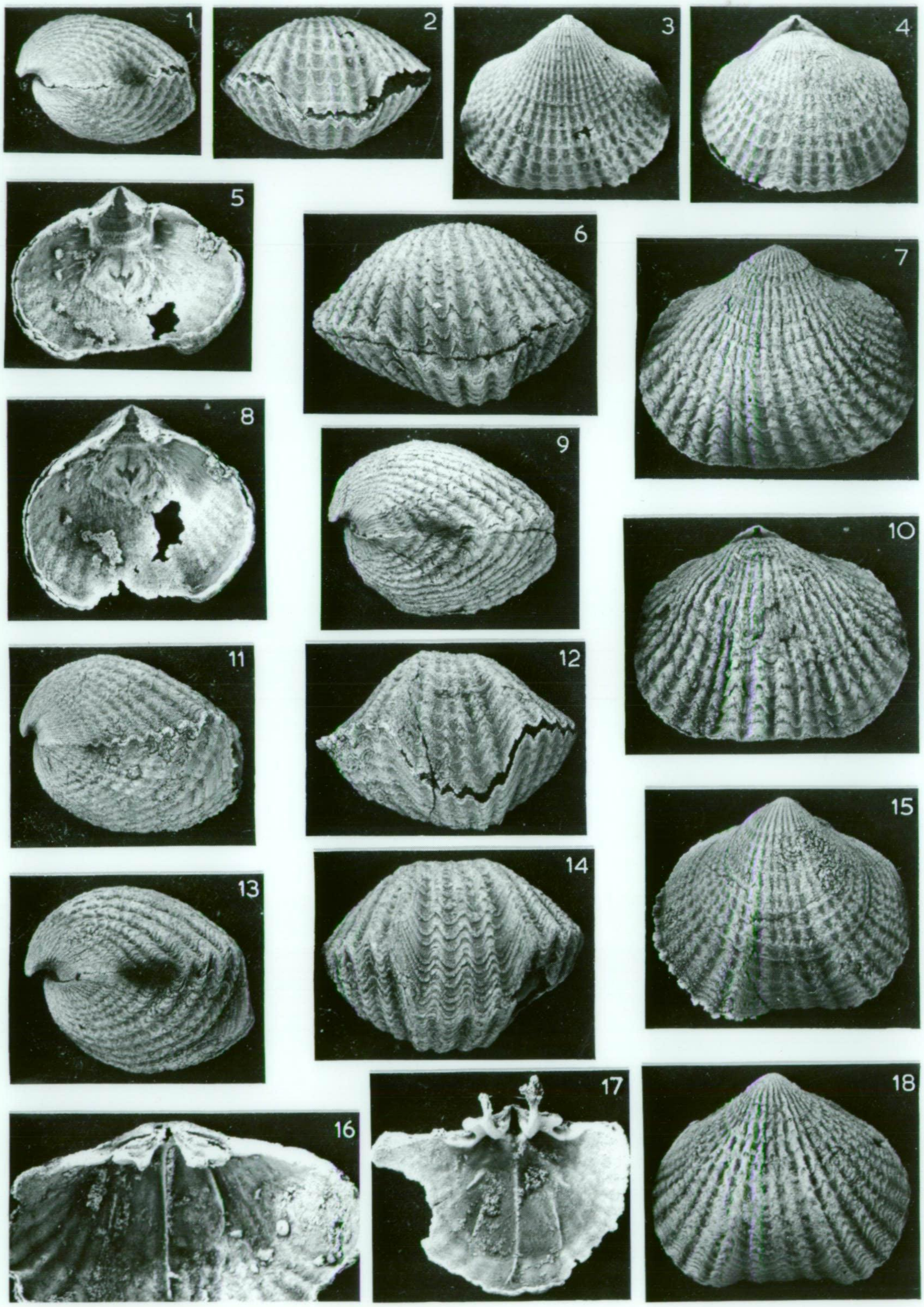
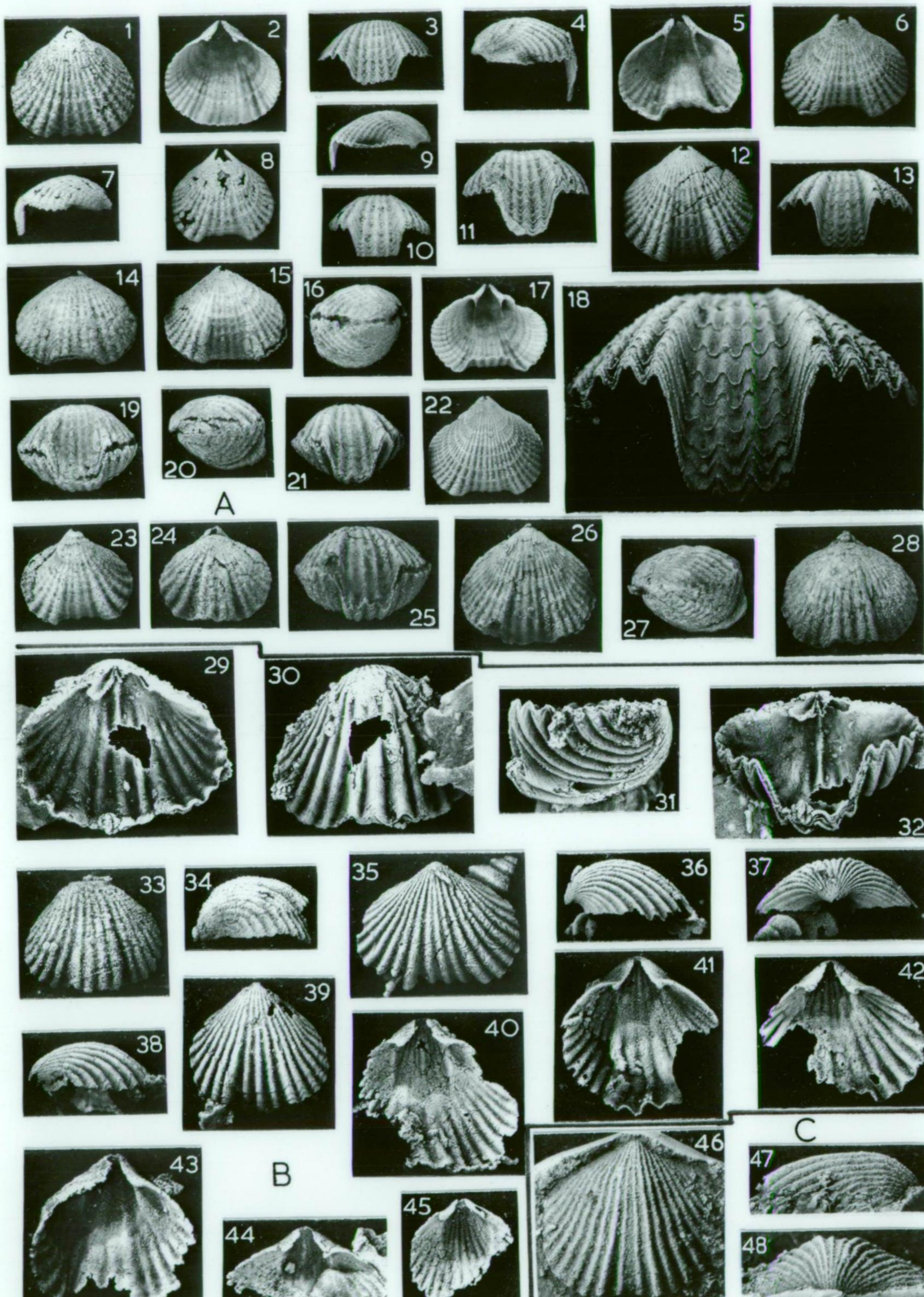
PLATE 22



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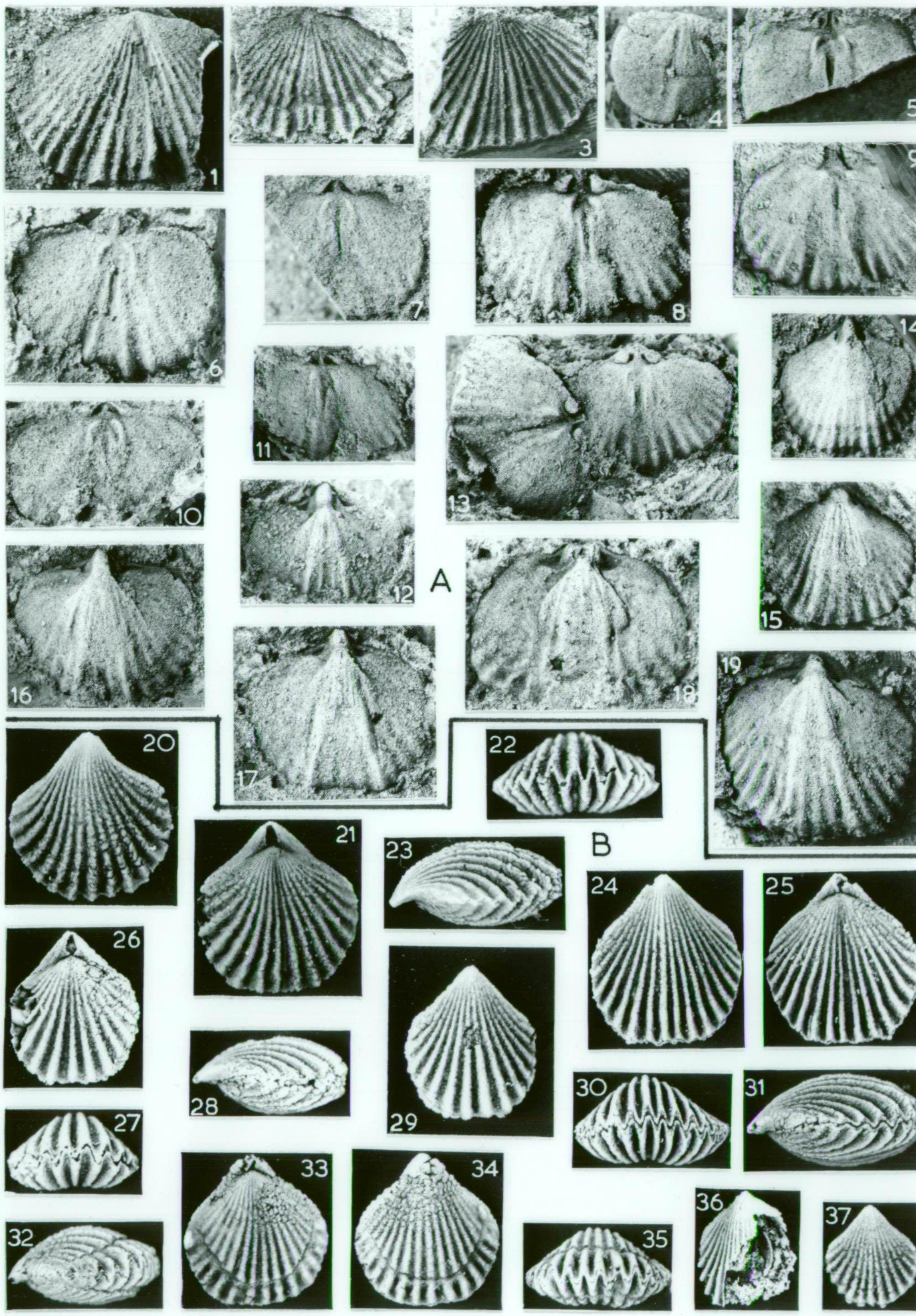
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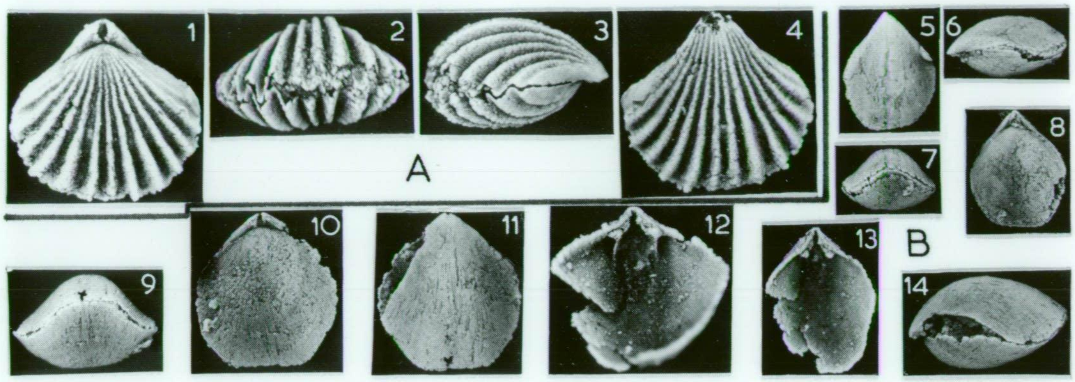
PLATE 26



APPENDIX 2

Clive Burrett, John Laurie and Bryan Stait

on

GORDON SUB-GROUP (ORDOVICIAN) CARBONATES AT PRECIPITOUS BLUFF AND POINT CECIL, SOUTHERN TASMANIA, AUSTRALIA

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GORDON SUBGROUP (ORDOVICIAN) CARBONATES AT PRECIPITOUS BLUFF AND POINT CECIL, SOUTHERN TASMANIA, AUSTRALIA

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(with three text figures)

ABSTRACT

BURRETT, Clive, LAURIE, John and STAIT, Bryan, 1981 (30 ix): Gordon Subgroup (Ordovician) carbonates at Precipitous Bluff and Point Cecil, southern Tasmania, Australia. *Pap. Proc. R. Soc. Tasm.*, 115, 93-99 (with three figures). ISSN 0080-4703. University of Tasmania, Hobart, Tasmania, Australia.

The palaeogeographically and biostratigraphically important Ordovician carbonate sequence at Precipitous Bluff is at least 360 m thick. The lowest 130 m, the New River Beds, consist of bryozoan algal biospararenites of Chazyan to Blackriveran age. These beds were probably deposited in a high energy subtidal environment with minor periods of intertidal deposition. The upper 50 m of this lowest unit contains abundant *Calathium*, bryozoans and corals. The succeeding 230 m of biosparites, biomicrites, argillaceous carbonates and siltstones, the Precipitous Bluff Beds, are dominated by trilobites, brachiopods and bryozoans, range in age from Trentonian to Cincinnatian and were probably deposited in deeper water than the New River Beds.

The Prion Beach Beds at Point Cecil, five km south of Precipitous Bluff, are argillaceous micrites containing a trilobite/brachiopod fauna and include strata of Blackriveran and Trentonian age and are thus biostratigraphically correlated with the upper part of the New River Beds and at least part of the Precipitous Bluff Beds.

Vertical carbonates along New River Lagoon and sheared carbonates at Point Cecil suggest structural complications perhaps associated with a continuation of a large, possibly transcurrent fault, trending north along New River.

INTRODUCTION

This paper records the results of a reconnaissance geological survey of two palaeogeographically important areas of Ordovician carbonates. It will also form the basis for subsequent detailed biostratigraphic studies. Little geological work has been undertaken in this area mainly because of its isolation. Extremely thick vegetation makes geological work very difficult especially away from the cut tracks and no regional structural map can be produced at present.

Johnston (1888) showed 'Silurian' limestone along New River on his map and recorded a coral ('*Strombodes*') in limestone further north in the Cracroft River (State grid ref. Huon DN 6505). The next published work on the Ordovician limestone at Precipitous Bluff was that of Hughes (1957) who reported the chemical analysis of one sample and commented on its remarkable purity. No further work was carried out until 1979 when a party of the Australian and New Zealand School Exploration Society (ANZSES) led by Mr. Sean Kennedy collected small specimens at 10 m stratigraphic intervals (Banks in Hawkins 1980).

The argillaceous limestones east of Prion Beach along the western margin of Point Cecil were briefly investigated by Twelvetrees (1915), Blake (in Hughes, 1957), Banks (1962) and the ANZSES party (Kennedy in Hawkins, 1980).

The present study results from two trips to the Precipitous Bluff section (figs 1 and 2) and two trips to the Point Cecil sequence. Access to the general area is difficult but was facilitated by the use of a float plane landing in New River Lagoon and a helicopter landing (or hovering) near the Point Cecil locality allowing the removal of large specimens which could not otherwise be collected in any useful number.

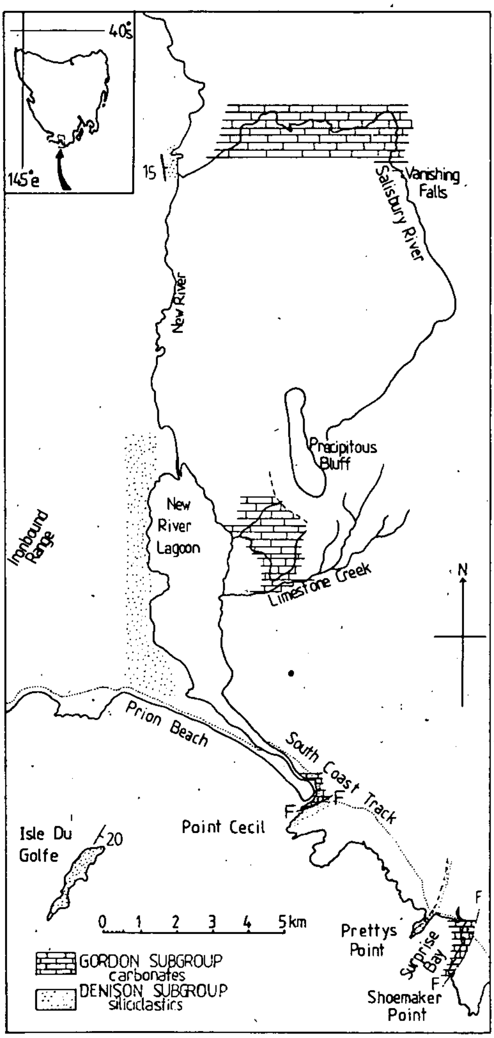

FIG. 1- Locality map showing part of Southern Tasmania. Extension of Denison Subgroup to north of Salisbury River and Isle du Golfe confirmed by helicopter reconnaissance in 1977 and 1979. F-F = Fault

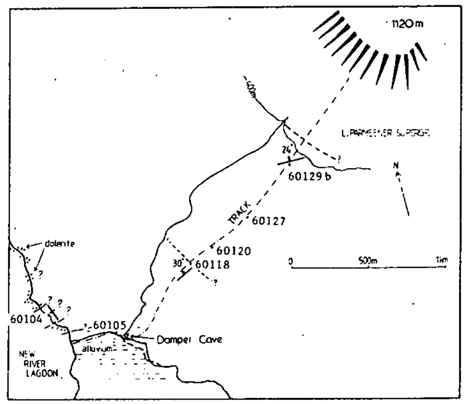

FIG.2.- Map showing position of collecting sites along walking track up Precipitous Bluf. Boundary between New River Beds and Precipitous Bluff Beds is shown just below 60118. Possible extent of the Lower Parmeener Supergroup (which contains Permian brachiopods) is indicated by dots.

PRECIPITOUS BLUFF

The southwestern flanks of Precipitous Bluf are covered by forest that ranges from fairly open to impenetrable. The section was measured along a narrow bushwalking track running up a ridge (State grid ref. Huon, DM664849-DM674861). The thick bush prevents tracing the rock types laterally. Outcrop is very poor from New River Lagoon to the base of a cliff above Damper Cave at grid ref. DM663852. Dolerite, of probable Jurassic age

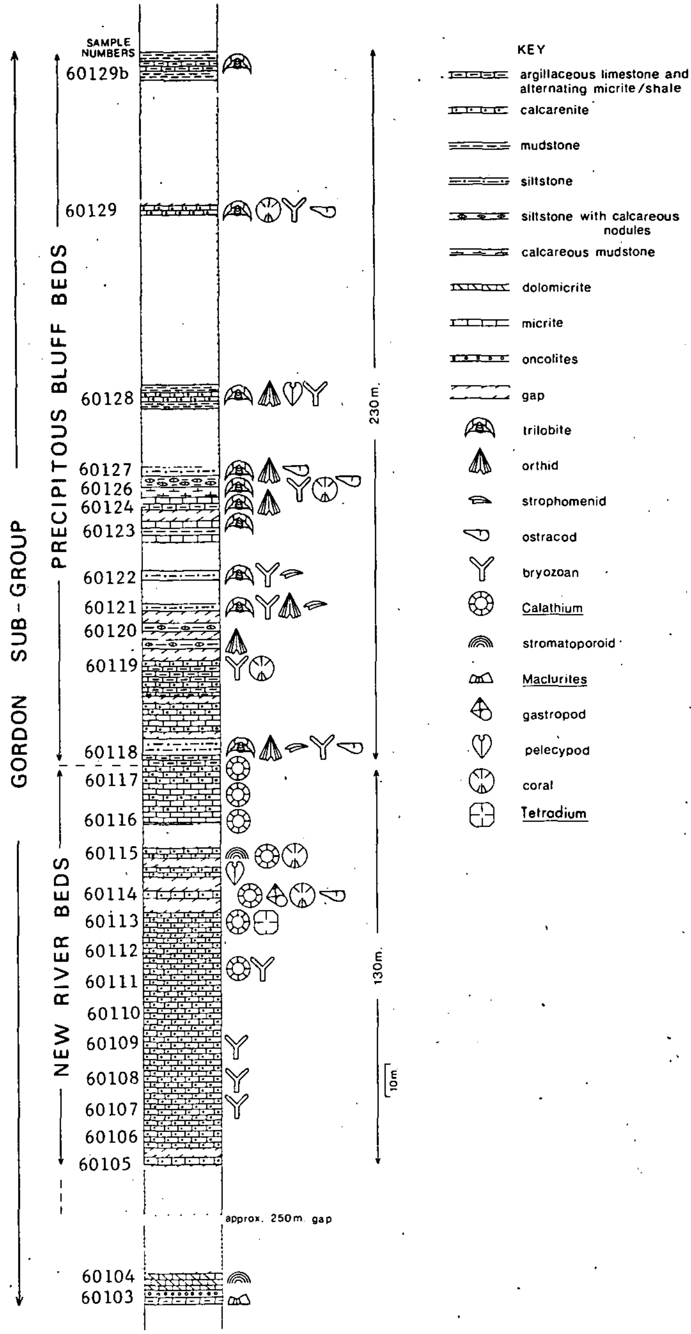

FIG.3.- Stratigraphic column of the Gordon Subgroup at Precipitous Bluff. The thickness of the stratigraphic gap (if any) between samples 60106 and 60105 is not known but could be as much as 250 m. Sample 60114 is dolointrasparite from an outcrop of vertically dipping carbonate. Sample 60115 is from the entrance (lower southern side) of Damper Cave. Sample numbers are catalogue numbers of the University of Tasmania, Geology Department rock collection.

outcrops along the eastern shore of New River Lagoon from the camp site at grid. ref. DM658851 to near the mouth of New River at DM648868. However one small outcrop of vertically-dipping limestone is present along the shore at grid. ref. DM655854.

The basal 130 m of the main sequence has excellent (about 80% outcrop) whereas the upper 230 m of the sequence contains many large stratigraphic gaps (see fig. 3). As only one narrow section was measured the sequence is not divided into formations, but rather, beds (Hedberg, 1976) are established awaiting a more complete survey of the regional geology.

Stratigraphy

Siliciclastics of the Denison Subgroup (?Late Cambrian-?Mesial Ordovician) outcrop on the western shore of New River Lagoon and along the Ironbound Range (Twelvetrees 1915) but were not investigated in this study.

Presumably the lowest 12 m of the carbonate sequence are vertically dipping and consist of a small (20 m x 12 m) outcrop on the eastern shore of New River Lagoon at grid ref. DM655854 (fig. 2). Impenetrable bush prevents tracing of this outcrop further east and no indication of facing was found. Rock types include dolointramicrudites and dolointrasparites. Five oncolites were found in one 20 mm thick bed (fig. 3). One stromatoporoid was found in the western part of the outcrop associated with several specimens of *Maclurites* sp. and other gastropods. Because of their very limited outcrop these intraclastic limestones have not been named. The restricted fauna, the abundant dolomite and the presence of oncolites suggests, by analogy with well-studied sequences elsewhere in the Gordon Subgroup, a peritidal (most likely low intertidal) depositional environment.

No conodonts were found in these beds. Elsewhere in the Gordon Subgroup *Maclurites* is found only in carbonates of Chazyan age (Banks and Johnson 1957; Banks and Burrett 1980).

New River Beds (Gordon Sub-group)

The *Maclurites*-containing carbonates mentioned above are probably separated from the basal units of the main carbonate sequence by a stratigraphic gap. The New River Beds (new name) are a sequence 130 m thick off cliff-forming, massively-bedded biocalcarenites and biomicrites outcropping on the lower western flanks of Precipitous Bluff between grid refs. DM661852 and DM665864. They dip generally towards the north, east and northeast at angles ranging from 0° to 32°.

The New River Beds are conformably overlain by the Precipitous Bluff Beds. Bedding averages 0.6 m in thickness, but many beds are lenticular. The New River Beds are mainly biospararenites, intraspararenites, biointraspararenites and biomicrites. Only one bed contains appreciable amounts (5%) of dolomite (sample UTGD 60113) though several horizons probably contain dedolomites.

Fauna and Flora - Fossils are difficult to see in the field due to recrystallization of the limestone, calcite veining and a covering of moss and lichen. However a major and obvious framework component (especially between samples UTGD 60111 and 60117) is the calcareous alga cf. *Calathium* which occurs as double-walled, cylindrical or conical structures averaging 35 mm in diameter. Corals including *Tetradium* and *Pycnolithus* (K. Kenna *pers. comm.*) are present in samples UTGD 60113 and 60114 respectively. In this section, bryozoa, echinodermata and various calcareous algae constitute, in varying proportions, the major bioclasts. Corals and ostracodes are significant, though minor constituents.

The biota is generally stenobiontic and in conjunction with the carbonate types suggests a generally subtidal, high energy environment. *Tetradium* and the dolomicrite of samples UTGD 60113 may represent intertidal conditions.

The basal 90 m of the New River Beds contain rare specimens of *Phragmodus flexuosus* Moskalenko, *Belodella copenhagenensis* (Ethington and Schumacher), *Drepanoistodus* *suberectus* (Branson and Mehl), *Belodina monitorensis* (Ethington and Schumacher) and *Panderodus gracilis* (Branson and Mehl). This fauna suggests a Chazyan age. Sample UTGD 60116 contains *Tasmanognathus careyi* which suggests a Blackriveran age (Burrett 1979)

Precipitous Bluff Beds (Gordon Sub-group)

The Precipitous Bluff Beds (new name) are a sequence 230 m thick of thinly-bedded siliceous siltstones, calcareous shales, biomicrites and biospararenites outcropping along a ridge from grid refs DM665854 to DM673859. These beds conformably overlie the New River Beds and are overlain unconformably by fossiliferous marine rocks belonging to the Lower Parmeener Supergroup of Late Carboniferous-Permian age.

The contact between the New River Beds and the overlying Precipitous Bluff Beds is gradational but within a 3 m thickness decalcified siltstone replaces biomicrite and thereafter siltstones and shales are common in alternations with biocalcarenites and biomicrites. Bedding thickness is variable (0.5 m - 50 mm) but beds are rarely thick.

Fauna - The 4 m thick basal siltstone is decalcified, buff-coloured and lithologically very similar to the Lords Siltstone Member in the Florentine Valley (Corbett and Banks 1974).

The brachiopod fauna includes most of the species found in the Lords Siltstone including *Strophomena* sp. nov., *Sowerbyites vesciseptus* Percival, but also contains *Ptychopleurella* sp. nov., *?Leptellina* sp., *Clitambonites* (*Clitambonites*) sp., *Skenidioides* sp. nov., *?Hallina*, *Sowerbyella* cf. *anticipata* Percival and a new genus of resupinate leptellinid. *Sowerbyites vesciseptus* and *Sowerbyella anticipata* occur in Fauna III (Eastonian) of New South Wales (Percival, *pers. comm).*

Trilobites from this level include *Remopleurides* sp., *Pliomerina* sp. and *Amphilichas* sp. (Banks, *pers. comm.*). A drepanellid ostracode (new genus A) is also common.

Conodonts are present in sample UTGD 60118 and include *Phragmodus undatus* (Branson and Mehl) and *Plectodina aculeata* (Stauffer) and suggest an Early Trentonian (Rocklandian) age.

Sample 60128 contains *Aphelognathus* sp. and sample 60129 contains *Oulodus robustus* (Branson, Mehl & Branson), *Pseudobelodina* sp., and *Aphelognathus shoshonensis* Sweet and suggests a Late Edenian-Mesial Maysvillian age.

POINT CECIL AREA

Prion Beach Beds (Gordon Subgroup) and Denison Subgroup at Point Cecil.

The argillaceous carbonates at Point Cecil to the east of Prion Beach (see fig. 2) were first mentioned by Twelvetrees (1915). Blake (in Hughes, 1957), described them as dark limestones alternating with slates. Banks (1962, p.170) recorded *Ampyx* and a cryptolithid close to *Eirelithus* from this locality and suggested a Mesial Ordovician age. The argillaceous limestones are thinly-bedded, steeply-dipping (between 75°-90°) and are faulted against the underlying Denison Subgroup quartz arenites. The basal limestone beds contain abundant detrital quartz. Further to the east (at DM677774 on South East Cape, 1:100 000 Sheet No. 8210) the Denison Subgroup quartz arenites are shallowly dipping (between 25°-30°) to the west and are, from the evidence of trough cross-bedding, right way-up. The quartz arenites are approximately 150 m thick, contain minor oligomict microconglomerates and overlie a conglomerate sequence of unknown thickness.

The argillaceous limestone outcropping along the western side of Point Cecil from grid ref. DM678775 to grid ref. CM681782 is herein named the Prion Beach Beds. Shearing and folding preclude any estimate of their true thickness but it is unlikely to exceed 200 m. Several small north-east trending transcurrent faults are present, extending for several metres approximately parallel to strike (N60°E). The drag dip on these transcurrent faults indicates sinistral movement. About 150 m north-northeast of this shear zone the limestones dip at 5^{o} to the northwest.

Fauna - The Prion Beach Beds contain an abundant fauna of fragmentary trilobites. More complete trinucleid trilobites are found 20 m north of the base of these beds and are associated with a brachiopod fauna that includes *Sowerbyella* cf. *lepta* Percival. A drepanellid ostracode (new genus A) is also found at this level. Conodonts are generally poorly preserved in these beds but include *Phragmodus undatus* in a sample not stratigraphically precisely located and *Phragmodus inflexus* Stauffer in a sample 10 m above the base of the beds. The former indicates a Trentonian or younger age and the latter indicates a Blackriveran age.

CONCLUSIONS

The carbonate sequence at Precipitous Bluff is divisible into 2 main lithostratigraphic units. The lower biospararenitic New River Beds were probably deposited in a subtidal environment. These beds were deposited during the Chazyan and Blackriveran at the same time as peritidal carbonates were deposited in many other parts of the state (e.g. Ida Bay, Florentine Valley, Vale of Belvoir, Everlasting Hills: Burrett 1979; Calver 1977; Weldon 1974). The higher parts of the New River Beds were also deposited at the same time as the deeper-water Prion Beach Beds. The succeeding Precipitous Bluff Beds suggest a deeper water environment and were deposited at the same time as very shallow subtidal-peritidal carbonates were deposited at Ida Bay and in the Florentine Valley and at the same time as part of the even deeper Prion Beach Beds.

The brachiopods from the base of the Precipitous Bluff Beds include elements found in the Florentine Valley and at Mole Creek but also include species only previously known from New South Wales.

The conodont fauna also allows correlation with deeper-water sequences outside Tasmania. Several important conodonts such as *Pseudobelodina* sp., *Aphelognathus shoshonensis* and *Phragmodus inflexus*, that facilitate precise intercontinental correlation, are found in this area but have not been found elsewhere in Tasmania. Further work in this area will undoubtedly reveal an Ordovician sequence of great importance in intercontinental correlations.

The vertically dipping carbonates along New River Lagoon and the sheared and possibly overturned sequence near Point Cecil suggests structural complications perhaps associated with the continuation of the transcurrent Lake Edgar Fault along New River as suggested by Corbett (1970).

ACKNOWLEDGEMENTS

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APPENDIX 1

Bryan Stait and John Laurie

on

LITHOSTRATIGRAPHY AND BIOSTRATIGRAPHY OF THE FLORENTINE VALLEY FORMATION IN THE TIM SHEA AREA, SOUTH-WEST TASMANIA

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LITHOSTRATIGRAPHY AND BIOSTRATIGRAPHY OF THE FLORENTINE VALLEY FORMATION IN THE TIM SHEA AREA, SOUTHWEST TASMANIA

by Bryan Stait and John Laurie
Department of Geology, University of Tasmania

(with three text figures)

ABSTRACT

STAIT, B. and LAURIE, J., 1980 (31 v): Lithostratigraphy and biostratigraphy of the Florentine Valley Formation in the Tim Shea area, southwest Tasmania. *Pap. Proc. R. Soc. Tasm.*, 114: 201-207. ISSN 0080-4703. Department of Geology, University of Tasmania, Australia.

The Florentine Valley Formation is defined. The Formation is subdivided into three members; the Churchill Sandstone Member, the Pontoon Hill Siltstone Member, and the Mt. Field Siltstone Member. Seven consecutive fossil assemblages based on brachiopods and trilobites can be recognised within the Florentine Valley Formation. International correlation of the assemblages in the Florentine Valley Formation is based on graptolites, that of the basal Karmberg Limestone on graptolites and conodonts. The Formation ranges in age from Early Tremadoc to Late Arenig.

INTRODUCTION

The Florentine Valley lies approximately 100 km west of Hobart. Access to the Valley is provided by the Gordon Road and by private logging roads owned and maintained by Australian Newsprint Mills (see fig. 1).

The Florentine Valley Formation outcrops on the eastern and southern sides of the Florentine Valley, along the eastern limb of the Florentine Synclinorium. The Florentine Valley Formation is best exposed in the southern end of the Valley along the Gordon Road, directly west of the Needles and along the Florentine Road at the Gap. A more detailed discussion of the geological setting can be found in Corbett and Banks (1974).

Lewis (1940) described within his Junee Series from the Tim Shea-Maydena area a fine-grained clastic sequence from which Kobayashi (1940) described a brachiopod, gastropod and trilobites. He assigned an Early Ordovician age to this fauna. The only previous description of the fauna from these beds was that of Etheridge (1904). Later Brown (1948) described a small brachiopod fauna from near Maydena and the Gap. To this she assigned an Early Ordovician age. Thomas (1960) and Quilty (1971) have illustrated graptolites from the Florentine Valley Formation. Faunal lists can also be found in Öpik (1951), Banks (1962) and Corbett (1963). Corbett and Banks (1974) described the lithostratigraphy of the Florentine Valley Formation in three sections (but did not establish formal members) and also established a preliminary biostratigraphy.

LITHOSTRATIGRAPHY

Banks (1962) formally raised the Florentine Valley Mudstone to the formational level. Corbett and Banks (1974) changed the name to the Florentine Valley Formation and defined it as "that formation of sandstone and siltstone with lesser limestone and chert which conformably overlies the Tim Shea Sandstone and Reeds Conglomerate and underlies the Gordon Limestone Sub-Group" (fig. 2). No type section was named and no boundaries were defined. Because no complete section of the Florentine Valley Formation exists it is necessary to define the base and the top of the Formation in different sections. Along the Gordon Road the top is faulted away and along the Florentine Road

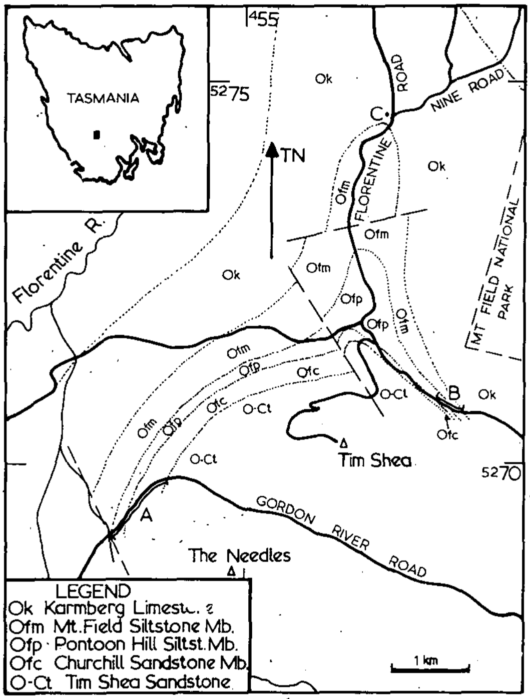

FIG. 1.- Map showing location of collected sections within the Florentine Valley.

the base does not outcrop.

The base of the formation is herein defined as occurring in a creek crossing the Gordon Road approximately 18 km from Maydena, just west of the Humboldt Divide, (State Grid. ref. Wedge 8112: 539698). This locality is on the western limb of the Tim Shea Anticline (see fig. 1). The base is chosen as the boundary between the coarse reddish sandstone typical of the Tim Shea Sandstone and the fine grey bioturbated sandstone above. The boundary is transitional. The top of the formation is defined as the base of the lowest lenticular body of limestone occurring in the cutting on the Florentine Road 150 metres east of the highest point on the road at the Gap (State Grid. ref. Wedge 8112:581707). The overlying formation is the Karmberg Limestone. This locality is on the eastern limb of the Tim Shea Anticline.

Corbett and Banks (1974) did not establish formal members, but following recent work by the authors it is now considered feasible to subdivide the Florentine Valley Formation into three members, as follows (fig. 3).

Churchill Sandstone Member (nov. (Nov.):- This is the basal member of the Florentine Valley Formation and occurs along the Gordon Road (State Grid. ref. Wedge 8112: Base 539698, top 535694). It consists of thickly-bedded, bioturbated grey sandstone containing rare gastropods, and is 75 m thick along the Gordon Road.

Pontoon Hill Siltstone Member (nov.):- This is the middle member of the Florentine Valley Formation, and is best exposed on the Gordon Road near the 12 mile post (19 km from Maydena), (State Grid. ref. Wedge 8112: Base 535694, top 529685). It consists of a basal white siltstone overlain by interbedded yellow siltstone and nodular siltstone, overlain in turn by dark grey calcareous siltstone and with interbedded yellow siltstone and nodular siltstone at the top. This member is 260 m thick along the Gordon Road and contains a diverse fauna of trilobites, brachiopods, gastropods, graptolites and ostracods.

Mt. Field Siltstone Member (nov.):- This is the uppermost member of the Florentine Valley Formation and is best exposed at the Gap. It consists of interbedded calcsiltstone, siliceous siltstone and fine siliceous sandstone overlain by finely bedded siltstone and is 55 m thick. It contains a diverse fauna of brachiopods, trilobites, gastropods, and graptolites. Underlying this member at the Gap are interbedded yellow siltstone and nodular siltstone of the Pontoon Hill Siltstone Member.

Corbett (1975) in describing the Upper Cambrian and Lower Ordovician sequences from the Denison Range, established the Denison Sub-Group, of which the uppermost formation is the Squirrel Creek Formation (fig. 2). Corbett (1975) divided the Squirrel

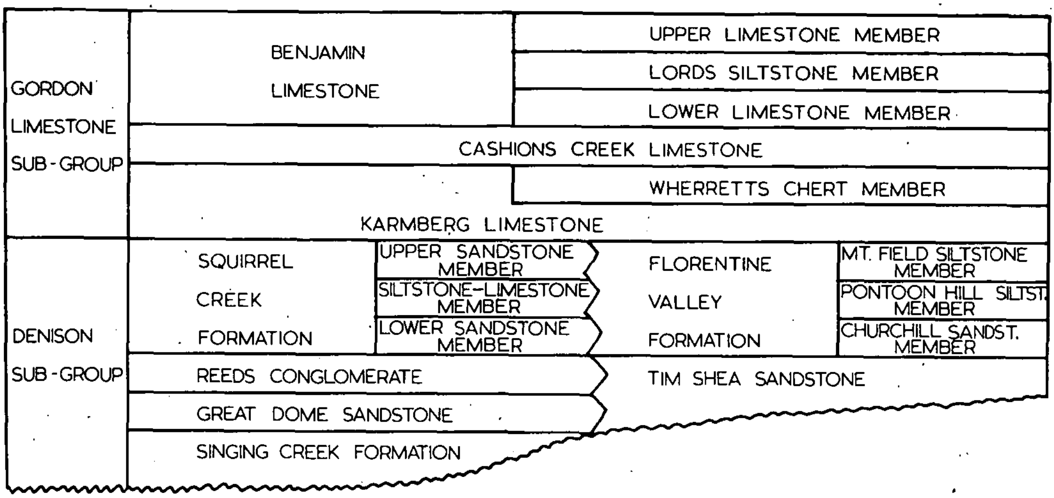

FIG. 2.- Denison Sub-Group and Gordon Limestone Sub-Group Stratigraphy (modified from Corbett and Banks 1974).

Creek Formation into three members: a Lower Sandstone Member overlain by a Siltstone-Limestone Member, of interbedded grey to yellow calcareous siltstone, fine sandstone and impure nodular limestone, and an Upper Sandstone Member. The two lower members are quite similar lithologically to the lower two members of the Florentine Valley Formation. The Upper Sandstone Member consists of grey-green and buff coloured quartoze and micaceous sandstone with inter-bedded siltstone with glauconite bands, and differs from the Mt. Field Siltstone Member of the Florentine Valley Formation in the predominance of sandstone, the presence of glauconite and in its much greater thickness.

From collections of fossils made by Corbett from the lower two members of the Squirrel Creek Formation it would appear that they are biostratigraphically equivalent to those of the Florentine Valley Formation.

BIOSTRATIGRAPHY

Recent work by the authors on the trilobites (Stait) and brachiopods (Laurie, in press), has made possible an initial biostratigraphic subdivision of the Florentine Valley Formation. Formal zones are not erected because of a reliance on only two sections which, to a large extent, do not overlap.

Within the formation can be recognised seven assemblages based on the ranges of

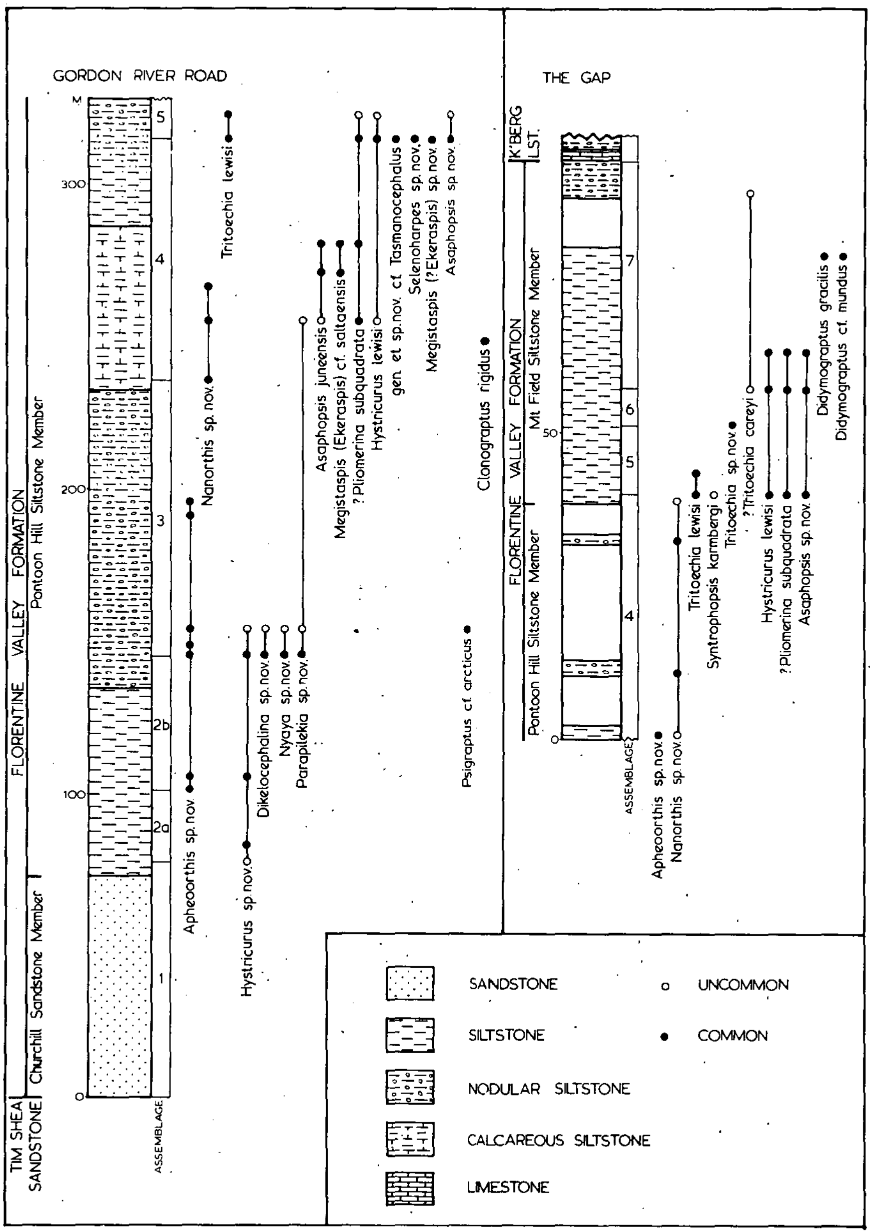

FIG. 3.- Stratigraphic sections of the Florentine Valley Formation showing the lithological units and the ranges of the faunal elements.

trilobites and brachiopod species (fig. 3). The two sections used to establish these assemblages are correlatable via assemblage 5 which occurs in both.

The assemblages are as follows:

Assemblage 1 :- *Lesueurilla* (identification, Dr. E. Yochelson pers. comm.)

Assemblage 2 :- *Hystricurus* sp. nov., *Westonia* sp., *Apheoorthis* sp. nov.

2a:- *Hystricurus* sp. nov., *Westonia* sp.

2b:- *Hystricurus* sp. nov., *Westonia* sp., *Apheoorthis* sp. nov.

Assemblage 3 :- *Hystricurus* sp. nov., *Parapilekia* sp. nov., *Dikelocephalina* sp. nov., *Nyaya* sp. nov., *Apheoorthis* sp. nov., *Psigraptus* cf. *arcticus* Jackson (identification, Dr. R.B. Rickards pers. comm.)

Assemblage 4 :- *Parapilekia* sp. nov., *?Pliomerina subquadrata* (Kobayashi), *Megistaspis (Ekeraspis)* cf. *saltaensis* (Kayser), *Asaphopsis juneensis* Kobayashi, *Hystricurus lewisi* (Kobayashi), *Nanorthis* sp. nov., *Clonograptus rigidus* (Hall).

Assemblage 5 :- *?Pliomerina subquadrata* (Kobayashi), *Megistaspis (Ekeraspis?)* sp. nov., *Selenoharpes* sp. nov., *Asaphopsis* sp. nov., gen. et sp. nov. (aff. *Tasmanocephalus*), *Hystricurus lewisi* (Kobayashi), *Tritoechia lewisi* Brown, *Syntrophopsis karmbergi* Brown.

Assemblage 6 :- *?Pliomerina subquadrata* (Kobayashi), *Hystricurus lewisi* (Kobayashi), *Asaphopsis* sp. nov., *Tritoechia* sp. nov. 1.

Assemblage 7 :- *?Pliomerina subquadrata* (Kobayashi), *Hystricurus lewisi* (Kobayashi), *Asaphopsis* sp. nov., *Tritoechia careyi* Brown, *Didymograptus gracilis*, *D.* cf. *mundus*, *Clonograptus* sp., *Tetragraptus* sp.

The UTGD catalogue members of the new species and genera can be found in Appendix 1, while the new classifications of specimens figured in Corbett and Banks can be found in Appendix 2.

The top of assemblage 7 fortunately coincides with the top of the Florentine Valley Formation. A diverse conodont fauna is found at the base of the Karmberg Limestone (Burrett and Stait, in prep.). Approximately five metres above this is a fauna containing *Leptella* sp. nov. This fauna correlates with the base of the Karmberg Limestone at Nine Road-Florentine Road junction (C. of fig. 1) which contains *Geragnostus* sp., *?Dimeropygiella* sp., aff. *Carolinites* sp., *Selenoharpes* sp., *Tasmanocephalus stephensi*, *Archaeorthis* sp. nov., *Tritoechia* sp. nov. 2, *Leptella* sp. nov.

Correlation of the Florentine Valley Formation is obtained from examination of assemblage 3 and upper assemblage 7 - lower Karmberg Limestone faunas. Assemblage 3 contains *Apheoorthis* and *Nyaya* which on the Siberian Platform occur in the Nyaika horizon (Sokolov and Tesakov, 1975). Rozova (1968) placed the Nyaika horizon at the base of the Ordovician, while Yadrenkina (1974) had the Khantaika horizon as the basal horizon with the Nyaika horizon above it. Assemblage 3 also contains *Psigraptus* cf. *arcticus* which occurs in Assemblage 3 of Cooper (1979) to which he assigned an age of Lancefieldian 1.5 (Early Tremadoc). The Florentine Valley Formation is approximately 100 m thick below this assemblage and the base may thus be Late Cambrian, although there is no faunal evidence to support this. Assemblage 4 contains *Clonograptus rigidus* which Cooper (1979) included in his Assemblage 4, to which he assigned a Lancefieldian 2 age (Late Tremadoc).

The upper part of assemblage 7 - lower Karmberg Limestone contains the graptolites *Didymograptus gracilis* (assemblage 7) and *Phyllograptus anna* and *P. ilicifolius* (lower Karmberg Limestone). The Karmberg Limestone graptolites indicate a correlation with the Upper *Didymograptus extensus* zone in the Skiddaw Group (Jackson, 1962), suggesting a Castlemanian age (Strachan 1972).

The conodonts from the base of the Karmberg Limestone are correlatable with the

Upper *Prioniodus (Oepikodus) evae* Zone (Dr. C. Burrett pers. comm.), which Lindström (1971) regarded as very Late Early Arenig (*Didymograptus nitidus* Zone).

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APPENDIX 1

University of Tasmania Geology Department catalogue numbers for the specimens of the genera and species mentioned in the text. This list is to enable checks on the assignments to be made before the taxonomic work appears.

Trilobites

Hystricurus sp. nov., U.T.G.D. 95972-76.
Parapilekia sp. nov., U.T.G.D. 95987-89.
Dikelocephalina sp. nov., U.T.G.D. 95977-82.
Nyaya sp. nov., U.T.G.D. 95983-86.
?Pliomerina subquadrata, U.T.G.D. 95992, 96000-05, 96028-29.
Megistaspis (Ekeraspis) cf. *saltaensis*, U.T.G.D. 95993-95.
Asaphopsis juneensis, U.T.G.D. 95991.
Megistaspis (Ekeraspis?) sp. nov., U.T.G.D. 96002-05, 96014-15.
Selenoharpes sp. nov., U.T.G.D. 96007-10.
Asaphopsis sp. nov., U.T.G.D. 96034-38, 96054.
gen. et sp. nov. (cf. *Tasmanocephalus*), U.T.G.D. 95999, 96021-27.
Hystricurus lewisi, U.T.G.D. 96039-44, 96052, 96073.

Brachiopods

Apheoorthis sp. nov., U.T.G.D. 97335-47.
Nanorthis sp. nov., U.T.G.D. 93748-63.
Tritoechia lewisi, U.T.G.D. 97366, 68, 71, 74-76, 80, 82, 84, 85.
Tritoechia sp. nov. 1, U.T.G.D. 97397-413.
Tritoechia sp. nov. 2, U.T.G.D. 97427-42.

APPENDIX 2

The assignments given to material figured in Corbett and Banks (1974) in the present study.

Trilobites

"Asaphopsis" juneensis - *Asaphopsis* sp. nov.
Hystricurus paragenulatus - *Hystricurus lewisi*.
Hystricurus sp. - *Hystricurus lewisi*.
"Asaphellus" lewisi - *Megistaspis (Ekeraspis?)* sp. nov.
Hystricurus cf. *paragenulatus* - *Hystricurus lewisi*
Cybelopsis sp. - *?Pliomerina subquadrata*

Brachiopods

Finkelnburgia cf. *bellatula* - *Apheoorthis* sp. nov.
Apheoorthis sp. -*Apheoorthis* sp. nov.
?Nanorthis - *Nanorthis* sp. nov.
Nanorthis cf. *hamburgensis* - *Nanorthis* sp. nov.
Nanorthis sp. - *Nanorthis* sp. nov.
Apheoorthis cf. *meeki* - *Apheoorthis* sp. nov.
Apheoorthis cf. *emmonsi* - *Apheoorthis* sp. nov.
?Tritoechia careyi - *Tritoechia* sp. indet.

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Laurie, J. R., 1980, Early Ordovician orthide brachiopods from southern Tasmania, Alcheringa, 4 (1), 11-23.